Ph.D. Dissertation of Public Health

Impact of long-term care deinstitutionalization on health and costs

장기요양 탈시설화가 건강 및 비용에 미치는 영향

August 2023

Department of health policy and administration
Graduate School of Public Health
Seoul National University

Sunghun Yun

Impact of long-term care deinstitutionalization on health and costs

지도교수 권 순 만

이 논문을 보건학 박사학위논문으로 제출함

2023년 3월

서울대학교 보건대학원
보건학과 보건정책관리학 전공

윤 성 훈

윤성훈의 박사학위논문을 인준함

2023년 5월

위 원 장	이 태 진	(인)
부위원장	김 홍 수	(인)
위 원	이 우 주	(인)
위 원	윤 난 희	(인)
위 원	권 순 만	(인)

Abstract

This study aims to examine two important research subjects. First, this study investigated whether the impact of long-term care deinstitutionalization on health and costs differs by the initial health status of the beneficiary. Given that many countries, including South Korea, use health as an important criterion for long-term care payment, and health is one of the important outcomes of long-term care policy, it is important to see if the effectiveness of deinstitutionalization varies with the level of health. However, few studies have empirically examined whether the effects of deinstitutionalization may vary by health status, despite the fact that many systems restrict access to institutionalized services in long-term care to the more severely impaired. Although the South Korea's system allowing relatively mild cases of elderly people to use institutional services is a questionable aspect of the system's effectiveness or efficiency, it is an advantage for analyzing whether the effects of deinstitutionalization vary across a wide range of severity. Using the case of South Korea, this study will empirically show that the benefits of deinstitutionalization can be greater for milder cases, both in terms of costs and health. Second, this study explored the underlying pathway beneath the effect of long-term care deinstitutionalization on health and costs. Borrowing the public health framework on healthy ageing, I have started by assuming that the key actionable dimensions affecting health outcomes of the older aged people - which are health care, long-term care, and environments - could be differently affected by long-term care institutionalization. This study empirically explored these pathways using variables such as preventable hospitalizations and emergency

room visits as proxy variables for medical care utilization, and medication use due to depression and hospitalization due to falls as proxy variables for the psychosocial and physical environments, respectively. The effect of long-term care institutionalization on the medical utilization pattern had been more deeply investigated, as it is one of the key factors affecting both health outcomes and costs.

Using the national health insurance and long-term care insurance data of the South Korean population who had newly acquired long-term care eligibility during 2016-2018 and by following them up-to 1 year, this study was able to portray the national level picture regarding the study subject. Two methodological issues arise regarding this study. First, as the decision regarding long-term care institutionalization is not randomly made, the results of the analysis will be misleading when the confounding covariates are improperly adjusted. Although it was unable to find appropriate instruments to borrow random treatment assignments, it was able to adjust variables that are not often available in claim data such as income level, informal caregiving resources, or prior medical utilization patterns, thanks to rich data from the national health insurance service (NHIS). Entropy balancing weights balancing the mean and variance of these baseline covariates had been derived, and weighted least square was applied to estimate the average treatment effect (ATE) of long-term care institutionalization compared to home and community base care. Second, the place of receiving long-term care could change over time. Although there was a small proportion of switch users (who had changed their place of receiving long-term care during 1-year follow-up) among the study sample, simply removing these switch users may cause bias as the decision regarding switching place may be affected by both the prior place of receiving long-term care and

other confounding covariates. In this study, these switch users were treated in several different ways (e.g., removing, assigning all switch users to the treatment group or the control group) to check the robustness of the results.

Results of the study have suggested that in general, long-term care deinstitutionalization is beneficial in terms of health and formal care costs, although the magnitude of this effect diminished as the initial health status of the beneficiary worsened. The effect of long-term care institutionalization on health outcomes in various measures including death, activities of daily living, instrumental activities of daily living, and cognition level was consistently shown to be negative. Regarding the effect of long-term care deinstitutionalization on formal care costs, long-term care costs (measured by using long-term care insurance claim data) and medical care costs (measured by using national health insurance claim data) had shown some different outcomes. Long-term care costs were higher among institutional care users compared to home and community based care users regardless of their initial health status at the baseline. However, medical care costs were smaller among the severest (grade 1-2) institutional care users compared to home and community based care users, although this was not the case among the less severe (grade 3-4, 5). In total, formal care costs including long-term care and medical care costs were higher among institutional care users, although the magnitude of this difference diminished as the initial health status of the beneficiary worsened. These results suggest that long-term care deinstitutionalization may be more beneficial among the less severe, and there may be an imbalance of long-term care utilization in the Korean context as two-thirds of institutional care users are less severe grade 3-5

beneficiaries.

Another important finding of this study is that it had empirically shown the underlying pathway beneath the effect of long-term care deinstitutionalization on health and costs. I have suggested that the dimensions affecting healthy ageing such as health care services, long-term care services, and environments could differ due to long-term care institutionalization, as it cannot be just seen as a type of service but a migration alienating one with their existing social and physical connections. Measures representing such dimensions were selected to empirically explore whether this actually is a case. Results of this study had shown that the risk of experiencing preventable hospitalization and inappropriate emergency room visits, risk of medical utilization due to depression, and risk of hospital admission due to hip fracture was all higher among the institutional care users, which may respectively represent the difference in health care services, social environments, and physical environments. The effect of long-term care institutionalization on medical care utilization was further explored, as it is one of the key concepts affecting both health outcomes and costs.

One of the unique findings of this study is that it conceptually divided the total effect of long-term care institutionalization on medical care utilization into two aspects - the direct effect affecting medical utilization patterns, and the indirect effect through a change in health status. While the indirect effect through health status change could be regarded as mere outcomes tied to health outcome differences, the direct effect on medical utilization patterns explains the underlying pathway of how long-term care institutionalization can affect both health and costs. In this study, the existence of negative direct effect of long-term care deinstitutionalization on medical

utilization patterns was suggested using logical interpretation of study results. Study results show that long-term care institutionalization may have negative total effect on medical care utilization, especially regarding outpatient services and inpatient services among the severest. Considering that long-term care institutionalization had shown negative effect on health outcomes, it is natural to assume that long-term care institutionalization may indirectly increase medical care utilization as the health status of their recipients worsened. In that sense, negative total effect on medical care utilization could be logically interpreted as the existence of negative direct effect, as the indirect effect through health status change may have positive value. Moreover, the results of causal mediation analysis quantitatively decomposing the direct and indirect effect had also supported the existence of negative direct effect, although these results should be interpreted with caution due to methodological limitations. These results could be interpreted in both ways. As the result showing that long-term care institutionalization increases the risk of preventable hospitalization implies, this negative effect could result in unmet medical needs among institutional care users and deteriorate health. On the other hand, as the result showing that long-term care institutionalization can reduce the utilization of long-term care hospitals and end-of-life acute hospital admission services implies, this effect could result in efficiency gains by replacing less effective and costly care. I suggest this negative direct effect on medical utilization patterns could affect the severest and the less severe differently. Among the less severe who could benefit more from the prevention and management of medical conditions, this negative direct effect on medical utilization would likely result in more unmet medical needs. Among the severest

whose needs shifted from prevention and management of medical conditions to care for a later dignified life, this negative direct effect on medical utilization would likely result in more efficiency gains.

Finally, this study further investigated which are the major disease categories where the negative direct effect of LTC institutionalization on medical utilization occurred, by subdividing the costs of NHI services according to the type of services (outpatient, LTCH admission, acute hospital admission, and other hospital admissions) and primary diagnosis of service utilization. Results show that those who are in long-term care institutions may experience more unmet needs regarding care for chronic kidney diseases or cares related to mobility and physical functions, while it may have potential to increase in efficiency regarding care for cancer.

The results of this study suggest that long-term care deinstitutionalization could be generally regarded as beneficial from the perspectives of healthcare system. However, it also shows that long-term care institutionalization could have some advantages among the severest older aged with long-term care needs, although it should be interpreted with caution as these results did not directly capture the impact on general well-being of life which could be different from health outcomes itself. Therefore, rebalancing the long-term care institutional service utilization based on the needs of the long-term care eligible persons would be an important policy direction to achieve better allocative efficiency of the long-term care system.

Keyword : long-term care, long-term care deinstitutionalization, health care utilization, health, cost
Student Number : 2019-36566

Table of Contents

Tables

Figures

Chapter 1. Introduction

We are living longer than ever before. Life expectancy at birth has increased from 62.3 years to 83.3 years during 1970-2019 in Korea[1]. Longevity could be generally considered a blessing, but not necessarily when two other facts are combined. First, we are living longer in unhealthier conditions. If we consider health-adjusted life expectancy (HALE), life expectancy in 2019 drops from 83.3 to 73.1[2]. This means that more and more people are in need for care, and health and social care services are needed for longer periods to meet the needs of the ageing population. Second, the sustainability of health and social care systems which had contributed to our longevity and well-being is being questioned. Although there are studies arguing that the effect of population ageing on medical expenditure growth could be a red herring mainly due to time-to-death expenditures (Hyun et al., 2016; Zweifel et al., 1999), its effect on costs for long-term care seems more persistent as age related disabilities are strongly correlated with long-term care costs (de Meijer et al., 2011). Moreover, in countries like Korea where a large share of the population is becoming older, revenues from social insurance contributions linked primarily to the labor market are expected to decline (Cylus et al., 2019). These results suggest that re-orientating health and social services to respond more effectively and efficiently to the needs of the older aged is an essential policy target in the era of population ageing.

One of the policy responses to population ageing has been to

[1] https://www.index.go.kr/unify/idx-info.do?idxCd=8016
[2] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-ghe-hale-healthy-life-expectancy-at-birth

encourage ageing in place - which is the ability of older people to live in their own homes and community safely, independently, and comfortably, regardless of age, income, or level of intrinsic capacity (WHO, 2015). Compared to institutional services, ageing in place or long-term care deinstitutionalization was supported as it is generally preferred by the older person and may have financial advantages in terms of healthcare expenditure (Norton, 2014). However, empirical evidence regarding the benefits of long-term care deinstitutionalization is not clear (Konetzka, 2014; Wysocki et al., 2015; Young et al., 2017). Even though the majority of evidence has suggested that institutional care services cost more in terms of formal healthcare costs (Blackburn et al., 2016; Chappell et al., 2004; Corder, 2017; Felix et al., 2011; Hollander & Chappell, 2007; Kichener et al., 2006; Kim & Yang, 2002; Marek et al., 2012; Shireman & Rigler, 2004; Werner et al., 2019), several studies showed that institutional care could be beneficial in terms of reducing inpatient service use (Bakx et al., 2020; Blackburn et al., 2016; Wysocki et al., 2014) and that the total formal care costs including both long-term and medical care services may not differ from home and community based care (Bakx et al., 2020). Moreover, several studies suggested that institutional care services may not cost more when the burden of informal caregiving is considered (Chiu et al., 2001; Stommel et al., 1993). Evidence regarding preference is also not clear, considering the results of studies showing that the preference for institutional care depends on health state (Guo et al., 2014; Wolff et al., 2008). Furthermore, systematic reviews on the literature showed that evidence regarding various health outcomes was not clear, showing mixed results across studies (Wysocki et al., 2014; Young et al., 2017).

Health is one of the key concepts related to long-term care deinstitutionalization of the older aged. First, health could be regarded as a key outcome consisting the well-being of the older aged. Considering the fact that individual preferences may fail to fully account for factors affecting the capabilities and broader well-being of the person (Brouwer et al., 2008; Coast et al., 2008) and the positive correlation between health-related quality of life and overall quality of life (Couzner et al., 2012), it would be beneficial to explicitly consider health as a key outcome of long-term care policy. Second, health status is considered as a key criterion determining the long-term care need and institutional care eligibility (Colombo et al., 2011). Therefore, changes in health status due to long-term care environments could affect long-term care needs and institutional care eligibility in the future. If the health of the individual could be more well preserved in home and community based environments, it will result in positive feedback affecting both health outcomes and decisions regarding long-term care deinstitutionalization. Third, the impact of long-term care deinstitutionalization may also differ by the individual's initial health status. Although less is studied about the differential effects among the subgroups (Wysocki et al., 2015), several studies indicated that the less severe ones could benefit more from long-term care deinstitutionalization (Kim & Yang, 2005; Mitchell, 1978). Taken together, the concept of long-term care deinstitutionalization could not be separated from the course of healthy ageing.

The world report on ageing and health (WHO, 2015) has defined healthy ageing as "the process of developing and maintaining the functional ability that enables well-being in older age", which was also adopted in the first *WHO Global Strategy and*

Action Plan on Aging and Health unanimously endorsed by all WHO member states during the World Health Assembly in May 2016. One of the noticeable contributions of this definition was that it extracted two crucial interacting components from the "functional ability of the older aged": "intrinsic capacity" and "environment." In their report, an intrinsic capacity is defined as the composite of all individual physical and mental capacities, and environments are defined as all other surroundings including the extent that societies promote equal opportunities, prevent inequities, combat ageing, and ensure access to affordable health and social systems (Michel & Sadana, 2017). In this regard, promoting healthy ageing can be achieved in two ways: by supporting the building and maintenance of intrinsic capacity and by building an enabling supportive environment (WHO, 2015).

Long-term care deinstitutionalization can affect the course of healthy ageing through various mechanisms affecting both intrinsic capacity and environments. This is because long-term care institutionalization is not just a type of long-term care service, but a migration alienating one with their prior social connection and the ways of life they have been enjoying on their own (Wiles et al., 2012). Long-term care institutionalization is much more than long-term care services combined with rooms and board services. Not only because it affects their physical and social environments, but also because the providers of institutional care services can affect the decision-making process regarding their resident's medical and long-term care service utilization through their workers (Travers et al., 2020). Considering the information asymmetry between the consumer of institutional care services and the service provider, providers may be able to distort the medical and long-

term care utilization of the consumers in order to maximize their own profits (Haas-Wilson, 2001), unless adequate policy structures exist. As the public health framework for healthy ageing suggests, medical services, long-term care services, and other environments are regarded as key actionable factors affecting healthy ageing (WHO, 2015). For example, medical services can prevent medical conditions, reverse or slow declines in capacity, and manage advanced conditions affecting intrinsic capacity. Long-term care and environments can slow down the decline in intrinsic capacity by promoting capacity-enhancing behaviors, and also support those with declined capacity in pursuing their well-being. Long-term care institutionalization can affect healthy ageing through all of these factors, which include the utilization of medical and long-term care services that can also lead to differences in total healthcare costs realized at the end.

Although there have been rising interests and movements toward long-term care deinstitutionalization around the OECD countries (Gori et al., 2015), there are several remaining questions that have been left behind without being fully addressed, which I am going to argue that they are closely related to understanding the key contextual factors constructing the heterogenous effect of long-term care deinstitutionalization. First, the question regarding who can benefit more from long-term care deinstitutionalization has not been properly addressed. In their systematic review, Wysocki and colleagues (2015) suggested that various subgroup analysis assessing differential effects of long-term care institutionalization should gain more interest. In this study, I have focused on the initial health status based on physical and cognitive ability to study whether the long-term care deinstitutionalization does actually

have a differential effect on health and costs. Although it is often recommended to encourage the less severe to use home and community based services and the severe to use institutional services (Konetzka, 2014; WHO, 2015), empirical evidence on this issue is scarce. Specifically, although there have been few studies addressing the differential effect of long-term care institutionalization on healthcare utilization (Kim & Lim, 2015; Schwarzkopf et al., 2013), study addressing their differential effect on health outcomes were even rare except for two studies which had shown that the positive effect of home and community based services on health could be greater among those with better baseline health status (Mitchell, 1978; Wieland et al., 2010). Second, studies on the mechanism of how long-term care institutionalization can affect health and costs were rare, which could be considered as key contextual factors underlying each setting. In this study, I start by borrowing the public health framework on healthy ageing (WHO, 2015) to empirically address that long-term care institutionalization can change their resident's medical care service and long-term care service utilization, along with the physical and social environments. Furthermore, the effect of long-term care institutionalization on medical care utilization has been further explored, as it could be the key underlying pathway affecting both health outcomes and costs. The effect of long-term care institutionalization on medical care utilization is especially important, because it could be affected by the health care delivery system within each context, and thereby explains why the effect of long-term care institutionalization differs among varying contexts.

The rest of the study is organized as follows. Chapter 2 will review the literatures on the key issues regarding this study. It will

show the context of the Korean long-term care system, address the key issues regarding long-term care deinstitutionalization, and will discuss the literature on the study topic and identify research gaps. In chapter 3, data and empirical strategy regarding the analysis of chapters 4 and 5 will be addressed, as both chapters share the same study population and analytical frameworks. Chapter 4 analyzes the differential effect of long-term care institutionalization on health outcomes, and further explored the underlying pathways of these effects borrowing the public health framework on healthy ageing (WHO, 2015). Chapter 5 analyzes the differential effect of long-term care institutionalization on formal medical and long-term care costs, and further explored the effect of long-term care institutionalization on medical care utilization. Chapter 6 concludes.

References

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020, Sep). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. Journal of Health Economics, 73, Article 102354. https://doi.org/10.1016/j.jhealeco.2020.102354

Blackburn, J., Locher, J. L., & Kilgore, M. L. (2016). Comparison of long-term care in nursing homes versus home health: costs and outcomes in Alabama. The Gerontologist, 56(2), 215-221.

Brouwer, W. B., Culyer, A. J., van Exel, N. J. A., & Rutten, F. F. (2008). Welfarism vs. extra-welfarism. Journal of Health Economics, 27(2), 325-338.

Chappell, N. L., Dlitt, B. H., Hollander, M. J., Miller, J. A., & McWilliam, C. (2004). Comparative costs of home care and residential care. The Gerontologist, 44(3), 389-400.

Chiu, L., Shyu, W. C., & Liu, Y. H. (2001). Comparisons of the cost-effectiveness among hospital chronic care, nursing home placement, home nursing care and family care for severe stroke patients. Journal of Advanced Nursing, 33(3), 380-386.

Coast, J., Smith, R. D., & Lorgelly, P. (2008). Welfarism, extra-welfarism and capability: the spread of ideas in health economics. Social Science & Medicine, 67(7), 1190-1198.

Colombo, F., Llena-Nozal, A., Mercier, J., & Tjadens, F. (2011). Help Wanted? https://doi.org/doi:https://doi.org/10.1787/9789264097759-en

Corder, M. R. (2017). Comparing total expenditures by source of long-term services and supports.

Couzner, L., Ratcliffe, J., & Crotty, M. (2012). The relationship between quality of life, health and care transition: an empirical comparison in an older post-acute population. Health and Quality of Life Outcomes, 10(1), 1-9.

Cylus, J., Roubal, T., Ong, P., & Barber, S. (2019). Sustainable health financing with an ageing population: Implications of different revenue raising mechanisms and policy options.

De Meijer, C., Koopmanschap, M., d' Uva, T. B., & Van Doorslaer, E. (2011). Determinants of long-term care spending: age, time to death or disability? Journal of Health Economics, 30(2), 425-438.

Felix, H. C., Mays, G. P., Stewart, M. K., Cottoms, N., & Olson, M.

(2011). Medicaid savings resulted when community health workers matched those with needs to home and community care. Health Affairs, 30(7), 1366-1374.

Gori, C., Fernandez, J.-L., & Wittenberg, R. (2015). Long-term care reforms in OECD countries. Policy Press.

Guo, J., Konetzka, R. T., & Dale, W. (2014). Using time trade-off methods to assess preferences over health care delivery options: a feasibility study. Value in health, 17(2), 302-305.

Haas-Wilson, D. (2001). Arrow and the information market failure in health care: the changing content and sources of health care information. Journal of health politics, policy and law, 26(5), 1031-1044.

Hollander, M. J., & Chappell, N. L. (2007). A comparative analysis of costs to government for home care and long-term residential care services, standardized for client care needs. Canadian Journal on Aging/La Revue canadienne du vieillissement, 26(S1), 149-161.

Hyun, K. R., Kang, S., & Lee, S. (2016). Population aging and healthcare expenditure in Korea. Health economics, 25(10), 1239-1251.

Kim, E.-Y., & Yang, B.-M. (2002). Economic evaluation of long-term care service. Korean Health Economic Review, 8(2).

Kim, E.-Y., & Yang, B.-M. (2005). Cost-effectiveness of long-term care services in South Korea. Archives of gerontology and geriatrics, 40(1), 73-83.

Kim, H. B., & Lim, W. (2015). Long-term care insurance, informal care, and medical expenditures. Journal of Public Economics, 125, 128-142.

Konetzka, R. T. (2014). The Hidden Costs of Rebalancing Long-Term Care. Health Services Research, 49(3), 771-777. https://doi.org/https://doi.org/10.1111/1475-6773.12190

Marek, K. D., Stetzer, F., Adams, S. J., Popejoy, L. L., & Rantz, M. (2012). Aging in place versus nursing home care: Comparison of costs to Medicare and Medicaid. Research in gerontological nursing, 5(2), 123-129.

Michel, J.-P., & Sadana, R. (2017). "Healthy aging" concepts and measures. Journal of the American Medical Directors Association, 18(6), 460-464.

Mitchell, J. B. (1978). Patient outcomes in alternative long-term care settings. Medical care, 439-452.

Norton, E. C. (2016). Chapter 16 - Health and Long-Term Care. In J. Piggott & A. Woodland (Eds.), Handbook of the Economics of Population

Aging (Vol. 1, pp. 951-989). North-Holland. https://doi.org/https://doi.org/10.1016/bs.hespa.2016.06.001

Schwarzkopf, L., Menn, P., Leidl, R., Graessel, E., & Holle, R. (2013). Are community-living and institutionalized dementia patients cared for differently? Evidence on service utilization and costs of care from German insurance claims data. BMC health services research, 13(1), 1-11.

Shireman, T. I., & Rigler, S. K. (2004). Penny wise, pound wise: a comparison of Medicaid expenditures for home and community-based services versus nursing facility care for older adults. Home Health Care Services Quarterly, 23(4), 15-28.

Stommel, M., Given, C. W., & Given, B. A. (1993). The cost of cancer home care to families. Cancer, 71(5), 1867-1874.

Travers, J. L., Hirschman, K. B., & Naylor, M. D. (2020). Adapting Andersen's expanded behavioral model of health services use to include older adults receiving long-term services and supports. BMC geriatrics, 20(1), 1-16.

Werner, R. M., Coe, N. B., Qi, M., & Konetzka, R. T. (2019). Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA internal medicine, 179(5), 617-623.

WHO. (2015). World report on ageing and health. World Health Organization.

Wiles, J. L., Leibing, A., Guberman, N., Reeve, J., & Allen, R. E. (2012). The meaning of "aging in place" to older people. The Gerontologist, 52(3), 357-366.

Wolff, J. L., Kasper, J. D., & Shore, A. D. (2008). Long-term care preferences among older adults: a moving target? Journal of Aging & Social Policy, 20(2), 182-200.

Wysocki, A., Butler, M., Kane, R. L., Kane, R. A., Shippee, T., & Sainfort, F. (2015). Long-term services and supports for older adults: A review of home and community-based services versus institutional care. Journal of Aging & Social Policy, 27(3), 255-279.

Wysocki, A., Kane, R. L., Dowd, B., Golberstein, E., Lum, T., & Shippee, T. (2014). Hospitalization of Elderly Medicaid Long-Term Care Users Who Transition from Nursing Homes. Journal of the American Geriatrics Society, 62(1), 71-78. https://doi.org/https://doi.org/10.1111/jgs.12614

Young, C., Hall, A. M., Gonçalves-Bradley, D. C., Quinn, T. J., Hooft, L., van Munster, B. C., & Stott, D. J. (2017). Home or foster home care

versus institutional long-term care for functionally dependent older people. Cochrane Database of Systematic Reviews(4).

Zweifel, P., Felder, S., & Meiers, M. (1999). Ageing of population and health care expenditure: a red herring? Health economics, 8(6), 485-496.

Chapter 2. Literature review

2.1 Contexts and characteristics of the Korean long-term care system

Korea introduced a universal long-term care system funded by social insurance in September 2008. Before 2008, rapid aging has led to an increase in long-term care needs but informal caregiving has decreased due to changes in family structure and an increase in the labor participation of women. Public funding for long-term care was available only for the poor through public welfare programs (Kwon, 2008). Moreover, as pensions were not sufficient to pay the costs of private long-term care and everyday life, long-term care hospitals covered by the NHI were an attractive option for non-poor older people with long-term care needs. Since Korea did not have any gatekeeping function and the majority of long-term care hospitals were private, providers were willing to accept non-medical admissions. Therefore, 'social admissions' in acute and long-term care hospitals became more prevalent (Kwon, 2008). Under these backgrounds, introducing a new formal long-term care system seemed to have the potential to reduce social admissions by acting as an efficient substitute, along with the primary goal of addressing an increase in long-term care needs.

Long-term care insurance (LTCI) is operated by NHIS (National Health Insurance Service), which is a centralized governmental agency that also administers NHI (National Health Insurance). As the Korean NHI does, the Korean LTCI has achieved universal coverage in terms of population coverage. Korean LTCI

levies social insurance contributions to all citizens, and also gives benefits to all citizens regardless of age, although it had established more stringent eligibility criteria for people under the age of 65 (Kwon, 2008). As the majority of services are delivered by private providers, NHIS' s role of purchasing is very important to sustain an adequate level of supply with efficiency. In order to receive benefits from LTCI, beneficiaries should apply for long-term care assessment for eligibility[3]. Long-term care assessment calculates an eligibility score that represents the amount of time needed for care, which is based on the functional status and whether nursing services or rehabilitation services are necessary. Beneficiaries are graded using certain cut-offs of such eligibility scores, and the range and amount of services they can receive differ by grade. Since this eligibility score and grades determine the size and intensity of the population who benefits from long-term care insurance, the stringency of eligibility criteria is one of the most important factors affecting the size of the formal long-term care market. This is true especially because long-term care providers are reimbursed based on per diem for facility services and pay-

[3] Contents included for assessment are: Type of disability and grade, physical functions(dressing, face-washing, toothbrushing, bathing, dining, changing positions, sitting, moving, control of excrement, shampooing and level of self-reliance), social functions(housing, preparing for meal, laundry, financial management, shopping, using telephone, using transportation, going out for short distance, dressing, taking peels), cognitive functions(recall of stories, date, place, age and birthday, difficulties in understanding directions, lack of judgment, difficulties in communication, difficulties in calculation, difficulties in understanding daily schedule, difficulties in recognizing family or relatives), change of behavior(newly occurred psychological symptoms related to dementia, delusion, anxiety, etc.), nursing necessity, rehabilitation necessity, willingness to use welfare equipment, main source of care, residential environment(evaluating whether environments are too harsh or detrimental to health), vision and hearing ability and morbidity.

per-visit (or hour) for home and community-based services in Korea. Therefore, the total volume of services utilized depends on the number of people who are eligible for long-term care services and the number of days they use the services, which are both subject to the stringency of eligibility criteria which is set by NHIS. Another important factor determining the size of the formal long-term care market purchased by the NHIS is the price of long-term care services. Providers are reimbursed based on a nationally negotiated fee-schedule, which are designed to reflect the cost of LTC services (Kwon et al., 2019). Fee-schedule is commonly applied nationwide although price level for the same services may differ by beneficiary' s level of deficiency, which is categorized by their grade of dependency.

As cash-benefits are allowed only in very restricted situations, two major categories of services are covered by LTCI - institutional care (IC) services and home and community based care (HC) services (NHIS, 2022). In general, only the severest grade 1 and 2 beneficiaries are allowed to choose IC services, but beneficiaries with milder grades are also allowed to use IC services in certain cases. Grade 3-5 beneficiaries are allowed to use IC services if they have dementia, if they live alone, or if their living environments are acknowledged by the regional committee to worsen their status. IC services are similar to nursing home services in other countries (Gori et al., 2015). Guides on the minimum level of human resources and infrastructures for IC services are specified by law (Lee & Kim, 2012). HC services consists of various services. Services could be categorized as home-visit services which are home-visit care, home-visit bathing, and home-visit nursing, short-term protection services such as

day-and-night care, and short-term-period care services. Selected lists of welfare equipment are also supported for HC users. HC users are entitled to receive services under the limit of maximum expenditure per month based on their eligibility grades. In Korea, costs and services regarding transportation are not covered by LTCI, and thus access to medical services could be hindered among those with problems regarding mobility, while IC services are obliged to contract with a physician for regular visits to ensure beneficiaries get access to medical care.

2.2 Long-term care deinstitutionalization and the goals of the health care system

As older people in need of long-term care typically have several chronic diseases (Beard et al., 2016), it is essential to have health and social services coordinated. This is especially important since inadequate prevention or control of chronic diseases may lead to more severe diseases, which will further incur hospitalization, deterioration, or even death (Beard et al., 2016). Therefore, the coordination between health care and social care is crucial regarding long-term care eligible population.

Improvement of a health care system might be in achieving the triple aim - improving the experience of care, improving the health of populations, and reducing per capita costs of healthcare (Berwick et al., 2008). In other words, effectiveness, efficiency, and responsiveness would be the key characteristics of a successful healthcare system, along with equity (WHO, 2000). Although it could be controversial to put the long-term care system under the

umbrella of healthcare system, it cannot be disputed that healthy ageing is also one of the key goals of a wider social welfare system supporting the independence and capability of older aged persons (Oxley, 2009). Moreover, it may also not be denied that the efficiency of such a system is crucial in order to achieve sustainability under the scarcity of resources. From such perspective, the triple aim of the healthcare system also fits the context of the long-term care system (Oxley, 2009).

Long-term care deinstitutionalization could be considered as a policy direction expected to achieve the triple aims of the healthcare system, although empirical evidence on health and costs is inconclusive (Konetzka, 2014; Wysocki et al., 2015; Young et al., 2017). Even under such uncertainty, long-term care deinstitutionalization has gained wide support under the concept of ageing in place, which is considered one of the principles of social welfare services. It shares the notion that it is a right of persons with disabilities to have freedom of choice to live in their own communities (Hendriks, 2007), and it is often considered as a role of human services to support older people to live an independent and normal life in their own community (Wolfensberger et al., 1972). In short, long-term care deinstitutionalization or ageing in place is sometimes considered as the end of the policy, not the means. Recent publications from health organizations such as WHO which considers long-term care as a part of broader health system also emphasizes the importance of ageing in place (WHO, 2015). However, as long-term care is an area where social services and health care services interwind, it should be considered whether the goals of two different services could be simultaneously realized. For example, as the integration of health and social care services in the

community is widely considered as a means to prevent long-term care institutionalization and encourage healthy ageing (Amelung et al., 2017), it should be first considered whether the goals of two different disciplines could be well harmonized. In other words, it is necessary to examine whether long-term care deinstitutionalization could be well aligned with the goals that have been previously stated as outcomes of the health system, in order to gain wider support in building the cooperative relationship between health care and social services. From such perspective, more extensive research on the ways to harmonize the difference in pre-existing resource allocation rules between the two different service systems are required. In this study, the impact of long-term care deinstitutionalization will be analyzed from the perspectives of the healthcare system, in order to first understand whether the fundamentals of both systems could get well-along with each other.

2.3 Literature on the effect of long-term care deinstitutionalization

Two review studies analyzing researches on the impact of long-term care deinstitutionalization found that the published literature at the time of the review was insufficient in quantity and quality to draw conclusions on the effect of long-term care deinstitutionalization (Wysocki et al., 2015; Young et al., 2017). Starting from these two review articles, I further explored the literature using backward and forward reference searching to find articles that cited or were cited by these articles. From the literature, I selected articles written in English or Korean that

analyzed the effects of using facility services versus home services on health outcomes and costs. Based on the additional articles identified, I further searched for articles that cited or were cited by these articles, as was done previously - and this was done repeatedly until no more literature met the criteria. The dependent variables were categorized into the following types of variables based on articles found: mortality, quality of life, ADLs (activity of daily livings), IADLs (instrumental activity of daily livings), cognitive function, mental health, symptom management and medication use, acute medical care utilization including hospitalizations, the cost of long-term care services, the cost from an insurer's perspective including the cost of long-term care services plus medical care, and the cost from societal perspective which includes the provision of informal care (Table 2.1). In addition, I summarized the characteristics of the articles included in the review by categorizing them as follows to further understand the results of the studies: observation period, background region, whether it is an experimental or quasi-experimental study, and control strategy to loosen confounding (Table 2.2).

The literature generally reports positive impacts of home and community based services compared to institutional care services on health outcomes such as physical functioning and mortality, and more positive impacts of institutional care services on hospitalization and acute care utilization, although there exists mixed findings. These findings are generally similar to those of relevant studies conducted in Korea. Previous studies comparing the health effects of institutional services and home and community based services in Korea which have analyzed the effects on ADLs or mortality, generally reported positive effects of home and

community based services compared to institutional care services (Choi & Joung, 2016; Jung & Lim, 2016; Lee & Cho, 2017; Lee et al., 2014; Lee et al., 2015).

The results of the literature on cost are relatively consistent. Most studies have reported lower costs for home and community based services compared to institutional care services, both when considering long-term care costs alone and when considering total costs for public payers including medical care costs. Only few exceptions were found in literature, where one did not incorporated covariate adjusting strategy (Naomi et al., 2012) while the other one did showed higher expenditure among institutional care users but the amount was small and statistically insignificant (Bakx et al., 20201). However, few studies argued that the costs of institutional care services could be lower compared to home and community based services when the cost of informal caregiver burden is accounted (Chiu et al., 2001; Stommel et al., 1993).

Although it seems that the literature supports the notion of ageing in place as it generally shows that home and community based services are better in terms of health outcomes and formal care costs compared to institutional care services, there remains several research gaps to be addressed, as it is still hard to conclude as there are several differences regarding the results of the literature (Wysocki et al., 2015; Young et al., 2017). Wysocki and colleagues (2015) points out that it could be the contextual factors affecting this heterogeneity in results. This study is going to explore what could be the core contextual factors regarding this heterogenous results. First, the question regarding who can benefit more from long-term care deinstitutionalization is going to be addressed. Given that health is one of the important goals of long-

term care policy and that many countries use health status as a criterion for determining long-term care benefits, it has important implications to see if the effectiveness of LTC places varies with health. Among the literatures reviewed, not many had studied the effect modification due to initial health status regarding this topic (Hollander & Chappell, 2007; Kim & Lim, 2015; Kim & Yang, 2005; Mitchell, 1978; Schwarzkopf et al., 2013; Wieland et al., 2010). To the best of the author's knowledge, two studies were the only literature analyzing whether the health effects of LTC placement depend on baseline health status, both conducted in the US and shown that the health benefit of long-term care deinstitutionalization could be greater among the less severe (Mitchell, 1978; Wieland et al., 2010). By comprehensively analyzing the impact of LTC place on a range of health outcomes and costs and further addressing whether this impact is modified due to initial health status, this study will refocus how baseline health status should be considered in determining eligibility for institutional care services.

Second, analysis focusing on the mechanism of how institutional care service can affect health outcomes and costs differently compared to home and community based services will be addressed. In this study, I start by borrowing the public health framework on healthy ageing (WHO, 2015) to empirically address that the place of receiving long-term care can affect health outcomes and costs by differently affecting medical care service and long-term care service utilization, along with the difference in physical and social environments. I further explore whether the medical utilization patterns are different among home and community base service users and institutional care users. In analyzing the differences in

medical care utilization, this study does not simply analyze the differences in total amount of medical care utilization between institutional care and home and community based service users, but rather seeks to show that the differences in total medical care utilization could be divided into the indirect effect mediated by the differences in health outcomes, and the direct effect that the patterns of medical care utilization actually differ between the two service users. In understanding the context which affects the heterogenous effect of long-term care deinstitutionalization, medical care utilization pattern is important because the underlying health care delivery system beneath each context determines the effect of long-term care deinstitutionalization on medical care utilization pattern, which in turn affects the cost and health differences. To the authors' knowledge, this is the first study to attempt to decompose the effect of long-term care place on medical care utilization into indirect effects due to differences in health outcomes and remaining direct effects. For example, of the studies that have reported reduced use of acute care hospitalizations among institutional care users compared to home and community based service users, some have interpreted this as an improvement in health outcomes, while others have interpreted it as a substitution of costly inpatient services. I believe that this divergence in interpretation of similar analytic result is due to failure in conceptually decomposing the underlying mechanism - that health outcome difference could mediate the effect on medical care utilization. In this study, various analysis will be addressed to show that LTC place can affect medical care utilization both ways - it can affect the pattern of medical care utilization directly, and indirect effect mediated by health outcome differences could also affect

total medical care utilization measured during the follow-up period. By showing that the impact of long-term care place on health and costs can be driven by differences in medical care utilization patterns among the two service settings, it may be able to shed light on why there exists a heterogenous effect of long-term care deinstitutionalization between differing settings and where current long-term care services need to be improved.

[Table 2.1] Results summary of the literature on the effect of long-term care deinstitutionalization

Dependent variable	HC service positive	IC service positive	Statistically insignificant
Mortality	Blackburn et al. (2016) Choi & Joung (2016) Chuang et al. (2005) McCann et al. (2009) Miller et al. (2008) Wieland et al.(2010)	Challis et al(1991) Lopes et al(2018)	Bakx et al.(2020)* Werner et al.(2019)*
Quality of life	Braun et al.(1987) Challis et al.(1991)	Kok et al.(2015)	Hulsman & Chubon(1989) Oktay et al.(1987)*
ADL	Condelius et al.(2010) Jung & Yim(2016) Lee & Cho(2017) Lee et al.(2014) Lee et al.(2015) Marek et al.(2005) Mitchell et al.(1978) Sherwood et al.(1986)	Kim & Yang(2005) Lopes et al(2018)	Chiu et al. (2001) Oktay et al.(1987)* Werner et al.(2019)*
IADL			Condelius et al.(2010)
Cognitive capacity	Lee et al.(2014) Marek et al.(2005)	Lopes et al(2018)	
Mental health	Marek et al.(2005)		
More intensive symptom management and medication		Mitchell et al.(2004) Rigler et al.(2004)	
Less frequent acute medical care (i.e., hospitalization, emergency room visit)	Condelius et al.(2010) Kim & Lim (2015)* Kim et al.(2019) Newcomer et al.(2018)	Bakx et al.(2020)* Blackburn et al.(2016) Konetzka et al. (2020)* Schwarzkopf et al.(2013) Werner et al.(2019)* Wilson et al.(2005) Wysocki et al.(2014)	Mitchell et al.(2004)
Costs of LTC	Blackburn et al.(2016) Miller et al.(2008)		
Costs of insurer	Blackburn et al.(2016) Chappell et al.(2004) Corder(2017) Felix et al.(2011) Hollander·Chappell(2007) Kim & Yang(2002)	Naomi et al.(2012)	Bakx et al.(2020)*

	Kitchener et al.(2006) Marek et al.(2012) Park (2010) Shireman&Rigler(2004) Werner et al.(2019)*		
Societal costs	Chappell et al.(2004) Kim & Yang(2002) Kok et al.(2015) Park (2010)	Chiu et al.(2001)	Stommel et al.(1993)

* These articles incorporated experimental or quasi-experimental design (See Table 2.2 for details). However, the results of Bakx et al. (2020), Kim & Lim (2015) should be interpreted with caution since they have studied the effect of 'eligibility' but not the service utilization. Moreover, it should also be noted that the target population of Werner et al.(2019) study is focused on those in need of post-acute care.

[Table 2.2] Summary of key characteristics of literature on the effect of long-term care deinstitutionalization

Study	Observation period	Background region	Control strategy
Experiments or Quasi-experiments			
Bakx et al.(2020)	2 years	Netherlands	Used the leniency of randomly assigned eligibility investigator as an instrumental variable. Estimated the effect of institutional care eligibility.
Kim & Lim (2015)	1 year	Korea	Regression discontinuity design using the cut-offs of eligibility score. Estimated the effect of higher-grade benefit eligibility.
Konetzka et al. (2020)	1 year	USA	Used county percentage of nonelderly long-term care users who received HCBS as an instrumental variable. Further adjusted county fixed-effects.
Oktay et al. (1987)	1 year	USA	Randomized controlled trial.
Werner et al.(2019)	30 days	USA	Used the distance to nearest in-home services and nearest facility services as an instrumental variable. Target population was in hospital discharged post-acute care setting.
Other observational studies			
Blackburn et al.(2016)	1 year	Alabama(USA)	Performed propensity score matching using age, gender, race, marital status, physical function, healthcare utilization, medical diagnoses
Braun et al.(1987)	3 months	Hawaii(USA)	Performed matching based on variables such as ADLs, disease diagnoses, age
Challis et al.(1991)	12 months	England	Without any specific control strategy, suggested that the baseline characteristics of the control and treatment groups were similar in terms of age and disability
Chappell et al.(2004)	1 year	Canada	Utilized tools for disability levels to compare groups with similar disabilities
Chiu et al. (2001)	3 months	Taiwan	Descriptive comparisons without control variables
Choi · Joung(2016)	40 months	Korea	Gender, age, income level, ADLs were controlled

Chuang et al.(2005)	6 months	Taiwan	Multivariate analyses controlling for age, gender, previous stroke history, physical function
Condelius et al.(2010)	3-5 years	Sweden	Descriptive comparisons without control variables
Corder(2017)	2 years	Louisville(USA)	Conducted IPW analysis utilizing variables such as gender/age/race/marital status/Medicare and Medicaid enrollment and duration/severity scale
Felix et al.(2011)	3 years	Arkansas(USA)	Performed PSM-DID analysis with variables such as gender/age/race/Medicaid, Medicare Benefit Group/Comorbidity Level/Previous Medicaid Spending Level
Hollander · Chappel(2007)	2 years	Canada	Comparisons using homogeneity between groups with the same eligibility grade
Hulsman et al.(1989)	Cross sectional	USA	Descriptive comparisons without control variables
Jung · Yim(2016)	2 years	Korea	Descriptive comparisons without control variables
Kim · Yang(2002)	3 months	Korea	Controlled sex/age/spousal status, initial physical function and cognitive function scores
Kim · Yang(2005)	3 months	Korea	Performed a multivariate analysis controlling for gender, age, marital status, and previous physical functioning status.
Kim et al.(2019)	5 years	Korea	Survival analysis was performed by time-dependent cox regression with the following control variables: gender, age, region (urban/rural), household income, primary caregiver, cohabitant, fracture risk, gait status, long-term care level, CCI, ADL, cognitive function, behavioral impairment score, and private/public status of the long-term care facility where services were provided.
Kitchener et al.(2006)	1 year	USA	Categorized and compared users by severity
Kok et al.(2015)	1 year	Netherlands	Propensity score matching with variables such as gender, age, functional impairment, chronic disease, mental illness, household size, education

Lee · Cho(2017)	1 year	Korea	Propensity score matching using gender, age, geography, health insurance eligibility type, housing, primary caregiver, comorbidities
Lee et al.(2014)	2 years	Korea	Conducted multivariate analyses controlling for demographic characteristics, ADLs, IADLs, cognitive function, behavioral disorders
Lee et al.(2015)	1 year	Korea	Propensity score matching using gender, age, region (urban/rural), ADLs, cognitive function, primary caregiver, medical insurance status, wounds, dementia, stroke, hypertension, diabetes, musculoskeletal conditions
Lopes et al.(2018)	1 year	Portugal	Survival analysis of death without confounders. Multivariate analysis of physical and cognitive functioning, controlling for age, gender, marital status, education, illness, and physical and cognitive functioning at the time of service access.
Marek et al.(2005)	30 months	Missouri(USA)	Matching using variables such as Medicaid eligibility, ADLs, cognitive function, age, and time of hospitalization.
Marek et al.(2012)	1 year	Columbia(USA)	Controlling for high inpatient Medicare cost in the 6 months prior and the 10 most frequently occurring chronic conditions
McCann et al.(2009)	5 years	North Island	Cox-proportional hazard model controlling for variables such as age, gender, general health, and marital status.
Miller et al.(2008)	28 months	USA	Multivariate logistic analysis controlling for disability, medical conditions, and demographic characteristics.
Mitchell et al.(1978)	3 months	USA	Multivariate analysis controlling for physical functioning, health risks
Mitchell et al.(2004)	1 year	Michigan(USA)	Performed a multivariate analysis controlling for variables such as age, race, gender, functional status, ethnicity, cognitive function, and time from hospitalization to death.

Naomi et al.(2012)	1 months	Japan	Compared before and after costs when a user moves from a facility to their home
Newcomer et al.(2018)	12 months	California(USA)	Descriptive comparisons without control variables
Park(2010)	1 months	Korea	Descriptive comparisons without control variables
Rigler et al.(2004)	1 year	Kansas(USA)	Performed a multivariate analysis controlling for variables such as gender, age, race, and average monthly prescriptions.
Schwarzkopf et al.(2013)	1 year	Germnay	Stratified subgroups using initial care needs level, and further adjusted age, gender, the interactions 'age*gender', 'age*setting' and 'gender*setting' as well as for proximity to death and comorbidity.
Sherwood et al.(1986)	9 months	USA	Controlled demographic, functional status, and pre-exposure measures of outcome variables
Shireman&Rigler(2004)	9 months	Kansas(USA)	Controlled gender, age, race, and disease
Stommel et al.(1993)	3 months	Michigan(USA)	Descriptive comparisons without control variables
Wieland et al.(2010)	5 years	South Carolina(USA)	Controlled the risk of death (PACE Prognostic Index) at baseline prior to choosing a place of long-term care
Wilson et al.(2005)	2 years	Canada	Descriptive comparisons without control variables
Wysocki et al.(2014)	12 months	USA	Performed matching using variables such as gender, age, ethnicity, housing, medical diagnosis, ADLs, cognitive function, etc.

References

Amelung, V., Stein, V., Goodwin, N., Balicer, R., Nolte, E., & Suter, E. (2017). Handbook integrated care. Springer.

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020, Sep). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. Journal of Health Economics, 73, Article 102354. https://doi.org/10.1016/j.jhealeco.2020.102354

Beard, J. R., Officer, A., De Carvalho, I. A., Sadana, R., Pot, A. M., Michel, J.-P., Lloyd-Sherlock, P., Epping-Jordan, J. E., Peeters, G. G., & Mahanani, W. R. (2016). The World report on ageing and health: a policy framework for healthy ageing. The lancet, 387(10033), 2145-2154.

Berwick, D. M., Nolan, T. W., & Whittington, J. (2008). The triple aim: care, health, and cost. Health Affairs, 27(3), 759-769.

Blackburn, J., Locher, J. L., & Kilgore, M. L. (2016). Comparison of long-term care in nursing homes versus home health: costs and outcomes in Alabama. The Gerontologist, 56(2), 215-221.

Braun, K. L., & Rose, C. L. (1987). Geriatric patient outcomes and costs in three settings: nursing home, foster family, and own home. Journal of the American Geriatrics Society, 35(5), 387-397.

CHALLIS, D., Darton, R., Johnson, L., Stone, M., & Traske, K. (1991). An evaluation of an alternative to long-stay hospital care for frail elderly patients: II. Costs and effectiveness. Age and Ageing, 20(4), 245-254.

Chappell, N. L., Dlitt, B. H., Hollander, M. J., Miller, J. A., & McWilliam, C. (2004). Comparative costs of home care and residential care. The Gerontologist, 44(3), 389-400.

Chiu, L., Shyu, W. C., & Liu, Y. H. (2001). Comparisons of the cost-effectiveness among hospital chronic care, nursing home placement, home nursing care and family care for severe stroke patients. Journal of Advanced Nursing, 33(3), 380-386.

Choi, J.-k., & Joung, E. (2016, 2016/07/01/). The association between the utilization of long-term care services and mortality in elderly Koreans. Archives of gerontology and geriatrics, 65, 122-127. https://doi.org/https://doi.org/10.1016/j.archger.2016.03.013

Chuang, K.-Y., Wu, S.-C., Yeh, M. C., Chen, Y.-H., & Wu, C.-L. (2005). Exploring the associations between long-term care and mortality rates among stroke patients. The journal of nursing research: JNR, 13(1), 66-74.

Condelius, A., Hallberg, I. R., & Jakobsson, U. (2010). Medical healthcare utilization as related to long-term care at home or in special accommodation. Archives of gerontology and geriatrics, 51(3), 250-256.

Corder, M. R. (2017). Comparing total expenditures by source of long-term services and supports.

Felix, H. C., Mays, G. P., Stewart, M. K., Cottoms, N., & Olson, M. (2011). Medicaid savings resulted when community health workers matched those with needs to home and community care. Health Affairs,

30(7), 1366-1374.

Hendriks, A. (2007). UN Convention on the Rights of Persons with Disabilities. European Journal of Health Law, 14(3), 273-298.

Hollander, M. J., & Chappell, N. L. (2007). A comparative analysis of costs to government for home care and long-term residential care services, standardized for client care needs. Canadian Journal on Aging/La Revue canadienne du vieillissement, 26(S1), 149-161.

Hulsman, B., & Chubon, S. J. (1989). A comparison of disabled adults' perceived quality of life in nursing facility and home settings. Public health nursing, 6(3), 141-146.

Jung, W.-S., & Yim, E. S. (2016). Factors Associated with the changes in activities of daily living in order adults with stroke: a comparison of home care and institutional care. Journal of Korean Academy of Community Health Nursing, 27(4), 388-398.

Kim, E.-Y., & Yang, B.-M. (2002). Economic evaluation of long-term care service. Korean Health Economic Review, 8(2).

Kim, E.-Y., & Yang, B.-M. (2005). Cost-effectiveness of long-term care services in South Korea. Archives of gerontology and geriatrics, 40(1), 73-83.

Kim, H. B., & Lim, W. (2015). Long-term care insurance, informal care, and medical expenditures. Journal of Public Economics, 125, 128-142.

Kim, J., Choi, Y., & Park, E. C. (2019, May). Incidence of hip fracture among long-term care insurance beneficiaries with dementia: comparison of home care and institutional care services [Article]. Bmc Geriatrics, 19, 9, Article 152. https://doi.org/10.1186/s12877-019-1161-8

Kitchener, M., Ng, T., Miller, N., & Harrington, C. (2006). Institutional and community-Based long-term care: A comparative estimate of public costs. Journal of health & social policy, 22(2), 31-50.

Kok, L., Berden, C., & Sadiraj, K. (2015, 2015/03/01). Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores. The European Journal of Health Economics, 16(2), 119-131. https://doi.org/10.1007/s10198-013-0557-1

Konetzka, R. T. (2014). The Hidden Costs of Rebalancing Long-Term Care. Health Services Research, 49(3), 771-777. https://doi.org/https://doi.org/10.1111/1475-6773.12190

Konetzka, R. T., Jung, D. H., Gorges, R. J., & Sanghavi, P. (2020, Dec). Outcomes of Medicaid home- and community-based long-term services relative to nursing home care among dual eligibles. Health Services Research, 55(6), 973-982. https://doi.org/10.1111/1475-6773.13573

Kwon, S. (2008). Future of long-term care financing for the elderly in Korea. Journal of Aging & Social Policy, 20(1), 119-136.

Kwon, S., Kim, T., Yun, S., & Song, Y. (2019). Development of costing methodology for adequate pricing of long-term care services study.

Lee, K., & Cho, E. (2017). Activities of daily living and rehabilitation needs for older adults with a stroke: A comparison of home care and nursing home care. Japan Journal of Nursing Science, 14(2), 103-111.

Lee, T. W., Cho, E., Yim, E. S., Lee, H. S., Ko, Y. K., Kim, B. N., & Kim,

S. (2015, 2015/02/01/). Activities of Daily Living in Nursing Home and Home Care Settings: A Retrospective 1-Year Cohort Study. Journal of the American Medical Directors Association, 16(2), 114-119. https://doi.org/https://doi.org/10.1016/j.jamda.2014.07.013

Lee, T. W., Yim, E., Cho, E., & Chung, J. (2014). Cognitive function, behavioral problems, and physical function in long-term care insurance beneficiaries with dementia in South Korea: comparison of home care and institutional care services. Journal of the American Geriatrics Society, 62(8), 1467-1475.

Lee, Y. K., & Kim, S. J. (2012). A study on the systematization of service quality management system of long-term care. Health and social welfare review, 32(4), 66-93.

Lopes, H., Mateus, C., & Rosati, N. (2018). Impact of long term care and mortality risk in community care and nursing homes populations. Archives of gerontology and geriatrics, 76, 160-168.

Marek, K. D., Popejoy, L., Petroski, G., Mehr, D., Rantz, M., & Lin, W.-C. (2005). Clinical outcomes of aging in place. Nursing research, 54(3), 202-211.

Marek, K. D., Stetzer, F., Adams, S. J., Popejoy, L. L., & Rantz, M. (2012). Aging in place versus nursing home care: Comparison of costs to Medicare and Medicaid. Research in gerontological nursing, 5(2), 123-129.

McCann, M., O' Reilly, D., & Cardwell, C. (2009). A Census-based longitudinal study of variations in survival amongst residents of nursing and residential homes in Northern Ireland. Age and Ageing, 38(6), 711-717.

Miller, J., Shi, X., & Cohen, M. (2008). Private long-term care insurance: Following an admission cohort over 28 months to track claim experience, service use, and transitions. Washington, DC: Assistant Secretary for Planning and Evaluation, US Department of Health and Human Services. Retrieved December, 4, 2009.

Mitchell, J. B. (1978). Patient outcomes in alternative long-term care settings. Medical care, 439-452.

Mitchell, S. L., Morris, J. N., Park, P. S., & Fries, B. E. (2004). Terminal care for persons with advanced dementia in the nursing home and home care settings. Journal of palliative medicine, 7(6), 808-816.

Naomi, A., Shiroiwa, T., Fukuda, T., & Murashima, S. (2012). Institutional care versus home care for the elderly in a rural area: cost comparison in rural Japan. Rural & Remote Health, 12(4).

Newcomer, R., Harrington, C., Hulett, D., Kang, T., Ko, M., & Bindman, A. (2018). Health care use before and after entering long-term services and supports. Journal of Applied Gerontology, 37(1), 26-40.

NHIS. (2022). 2021 Long term care insurance statistical yearbook.

Oktay, J. S., & Volland, P. J. (1987). Foster home care for the frail elderly as an alternative to nursing home care: an experimental evaluation. American Journal of Public Health, 77(12), 1505-1510.

Oxley, H. (2009). Policies for Healthy Ageing. https://doi.org/doi:https://doi.org/10.1787/226757488706

Park, C. J. (2010). Cost-effectiveness analysis of long-term care

services: Care in institutions vs In-home care. Korean Journal of Gerontological Social Welfare, 50, 145-171.

Rigler, S. K., Perera, S., Jachna, C., Shireman, T. I., & Eng, M. (2004). Comparison of the association between disease burden and inappropriate medication use across three cohorts of older adults. The American journal of geriatric pharmacotherapy, 2(4), 239-247.

Schwarzkopf, L., Menn, P., Leidl, R., Graessel, E., & Holle, R. (2013). Are community-living and institutionalized dementia patients cared for differently? Evidence on service utilization and costs of care from German insurance claims data. BMC health services research, 13(1), 1-11.

Sherwood, S., Morris, J. N., & Ruchlin, H. S. (1986). Alternative paths to long-term care: nursing home, geriatric day hospital, senior center, and domiciliary care options. American Journal of Public Health, 76(1), 38-44.

Shireman, T. I., & Rigler, S. K. (2004). Penny wise, pound wise: a comparison of Medicaid expenditures for home and community-based services versus nursing facility care for older adults. Home Health Care Services Quarterly, 23(4), 15-28.

Stommel, M., Given, C. W., & Given, B. A. (1993). The cost of cancer home care to families. Cancer, 71(5), 1867-1874.

Werner, R. M., Coe, N. B., Qi, M., & Konetzka, R. T. (2019). Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA internal medicine, 179(5), 617-623.

WHO. (2000). The world health report 2000: health systems: improving performance. World Health Organization.

Wieland, D., Boland, R., Baskins, J., & Kinosian, B. (2010). Five-year survival in a Program of All-inclusive Care for Elderly compared with alternative institutional and home-and community-based care. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, 65(7), 721-726.

Wilson, D., & Truman, C. (2005). Comparing the health services utilization of long-term-care residents, home-care recipients, and the well elderly. Canadian Journal of Nursing Research Archive, 138-154.

Wolfensberger, W. P., Nirje, B., Olshansky, S., Perske, R., & Roos, P. (1972). The principle of normalization in human services.

Wysocki, A., Butler, M., Kane, R. L., Kane, R. A., Shippee, T., & Sainfort, F. (2015). Long-term services and supports for older adults: A review of home and community-based services versus institutional care. Journal of Aging & Social Policy, 27(3), 255-279.

Wysocki, A., Kane, R. L., Dowd, B., Golberstein, E., Lum, T., & Shippee, T. (2014). Hospitalization of Elderly Medicaid Long-Term Care Users Who Transition from Nursing Homes. Journal of the American Geriatrics Society, 62(1), 71-78. https://doi.org/https://doi.org/10.1111/jgs.12614

Young, C., Hall, A. M., Gonçalves-Bradley, D. C., Quinn, T. J., Hooft, L., van Munster, B. C., & Stott, D. J. (2017). Home or foster home care versus institutional long-term care for functionally dependent older people. Cochrane Database of Systematic Reviews(4).

Chapter 3. Research methods

3.1 Data and subjects of the study

As it was found not possible to adopt quasi-experimental designs incorporated in previous studies with similar themes[4], this study had to rely on controlling observable variables. To include a broad range of covariates and study subjects, NHIS (National Health Insurance Services) data including a combined set of LTCI (Long Term Care Insurance) claims data and NHI (National Health Insurance) claims data was used. As Korea runs a universal but separate insurance schemes for long-term care and health care (Kim & Kwon, 2021), and as both insurance schemes are operated by a national level single purchaser, NHIS, it is possible to identify all claims and reimbursement records of the national population for

[4] Three different measures had been tested for the instrumental variable approach and failed to show persuasive characteristics. As it was not possible to acquire the information on the leniency of randomly assigned assessors which was used as an instrument in Bakx et al. (2020) study, I have tried 'the leniency of the regional committee (Si, Gun, Gu)' as an instrument but it has shown to have weak explaining power (F=1.7) and also failed to address persuasive result in the first stage regression. Werner et al. (2019) used the ZIP codes of the study sample in order to measure the distance to the closest long-term care institutions as an instrument, which was also not available in this study data. I have explored whether the 'long-term care supplier density of the region' could be used as an instrument, but the correlation between the instrument and observed confounding characteristics were found. Finally, I have tried 'the discontinuity of eligibility score regarding benefit grade judgement (Kim & Lim, 2015)' as an instrument. Although one cut-off (eligibility score 74.0) among the tested had shown persuasive characteristics as an instrument, the confidence interval in the 2-stage least square estimation was too wide (as the standard error was too large) and the estimated proportion of compliers was too small (3.3%, following codes of Baiocchi et al., 2014) to make proper judgements.

both schemes. Moreover, as NHIS collects contributions of both schemes, NHIS also has information on each individual's area of residence or income level, and as the eligibility to receive LTC services is assessed by NHIS, NHIS also has a broader range of information regarding the eligibility of LTC services[5] of the population who applied for LTC.

In this study, national data for the entire South Korean population newly eligible for formal LTC services during 2016-2018 were first identified. Those who failed to meet the following criteria had been removed from the sample and as a result, the final subjects of the study were 261,633 persons, and the final subjects of the study were followed up for a year.

- Those who were initially graded as grade 1-5[6]
- Those who were initially living in their own house
- Those who have utilized LTC service at least once during 1 year follow-up period

3.2 Measurement

Explanatory variable: Place of receiving long-term care

As the goal of the study is in identifying the effect of 'place of

[5] Information on functions (ADL, IADL, cognition), necessity of nursing or rehabilitation services, place of living, cohabitants, informal caregivers are gathered during the eligibility assessment. Details could be found in NHIS (2022).

[6] Those with grade 6 were removed from the study population, as they are restricted from receiving institutional care services

receiving long-term care (hereafter LTC place)' on health, health service utilization, and costs, determining and measuring such a concept is crucial. In Korea, formal LTC services could be separated into two broad categories: home and community based care (HC) services[7], and institutional care (IC) services, and this division based on the residential place is used as an explanatory variable in this study.

One of the main difficulties in measuring the explanatory variable of this study is that it could be changed over time- in this study, there were substantial switch users during the 1-year follow-up period. Among 261,633 subjects of the study, 15,882 subjects (6.1%) were switch users: and among switch users, 14,915 subjects (93.9%) initially used HC services while only 967 subjects (6.1%) were initial IC service users. As the size of switch users is comparable to pure institutional service users (21,370 subjects), and as a switch of services itself may imply a change in health conditions (especially those who switched to IC services), simply removing switch users may cause selection bias – it may result in selectively removing worsened cases from HC service users.

In this study, I used and reported three different strategies to measure the explanatory variable by treating switch users differently. First, an analysis of removing all switch users were performed. Second, the ever-home care user approach, which treats all switch users as HC users were performed. The third is the ever-institutional service user approach, treating all switch users as IC user. In general, no significant changes in the findings

[7] Home and community services includes home visit care, home visit bathing, home visit nursing, day and night care, short-term care, and support for welfare equipment. See NHIS (2022) for details.

of this study have been observed due to these strategies. Further sensitivity analysis using the intention-to-treat (ITT) approach, treating each user based on their initial choice of service, and operational definition approach, treating switch users who have spent more than half of the observation period in institutional services as IC users, were also performed.

Effect modification: Initial health status before entering LTC

One of the key goals of the study is to explore whether the effect of LTC place on health, healthcare utilization, and costs is different according to the initial health status of the beneficiary. In this study, the initial health status of LTC users before entering the service was categorized into three groups using LTC eligibility grades: severe (grade 1-2), moderate (grade 3-4), and mild but with cognitive impairments (grade 5).

In Korea, LTC eligibility grades are judged using certain cut-offs of LTC eligibility score which is intended to predict the amount of time needed for care[8]. Items included in the eligibility assessment are[9]: type of disability and grade, physical and social functions, cognitive functions, change of psychological behavior, nursing necessity, rehabilitation necessity, and decision tree models are used to predict the amount of long-term care service time (Han et al., 2011). Following the notion of WHO (2015) that measuring health based on mortality patterns and disease prevalence can

[8] Cut offs are set at 95, 75, 60, and 51 for grade 1-4. Dementia patients whose eligibility score is in between 45 and 51 are graded as grade 5, and dementia patients whose eligibility score is below 45 are graded as grade 6. Regional level committee are able to adjust maximum 5 points based on other factors such as doctor's opinion notes.

[9] See NHIS (2022) for details

reveal only part of health in older age (Beard et al., 2016), and assessment of functional ability is a better predictor of health outcomes in older ages (Lordos et al., 2008), I would like to argue that Korean LTC eligibility grade which reflects various aspects of functional abilities and their underlying physical and mental capacities is a reasonable tool for defining initial health status before entering LTC services.

The final subjects of this study are divided into three groups based on the following reasons. First, in Korea, only beneficiaries with grade 1 or grade 2 have freedom of choice in utilizing institutional care services. Those with grade 3-5 needs additional approval from the regional committee in order to enter institutional care facilities. This means that grade 1 and grade 2 beneficiaries could be distinguished from others not only by their health status but also by the underlying structure affecting the choice of LTC place, although these factors are intended to be neutralized in the main analysis by adjusting various factors described in the next section. Second, those with grade 3-4 and grade 5 could be distinguished as all participants with grade 5 has dementia. In 2014, Korea has expanded beneficiaries of formal LTC services by introducing a new grade, grade 5-those who have dementia but are only mildly dependent overall (45<LTC eligibility score<51). Baseline characteristics of final subjects and their subgroups are displayed in table 3.1, and it shows that the average level of functional ability among the three groups is distinguishable: the average ADL score is 0.7, 3.0, 4.4 and the average IADL score is 1.3, 2.9, 4.3, respectively for the severe, moderate, and mild but cognitively disabled groups. An additional sensitivity analysis

dividing study subjects into those who initially had dementia[10] and not was also performed.

3.3 Empirical strategy

The critical difficulty in analyzing the effect of LTC place on health, health service utilization, and costs is that the choice of LTC place is not random. The choice of LTC place could be affected by various factors, which could also affect the future health status or health service utilization of LTC users. For example, initial health status before receiving LTC services may affect the choice of LTC place, which obviously is related to future health status. Therefore, controlling initial health status before choosing an LTC place is crucial. Moreover, there are so many factors known to affect health (Krieger, 1994; Marmot, 2005) or health service use (Anderson & Newman, 2005), and many of these factors may also affect the decision of choosing an LTC place—which could be the cause of confounding when they are not properly adjusted.

In order to capture the actual effect of LTC place on health or relevant service utilization, it would be important to identify the set of factors that can confound the causal relation between the intervention and the outcome. Recent literature recommends using the causal diagrams along with a review of the subject-matter literature, to figure out whether using observed variables might be plausible in controlling possible confounding covariates (Hernan & Robins, 2020). In this study, I begin by using the LTC version of

[10] Study subject was regarded as dementia patient following the definition used in Yun & Lee (2022).

Anderson's expanded behavioral model of health services (Travers et al., 2020) as a key conceptual model for understanding the core lists of factors that can confound the effect of LTC place on health and health care utilization. The usefulness of this model in this study not only lies on the fact that it conceptualizes possible factors which could affect the use of LTC services, but it also explains the use of health services, as it is the expanded version of the model explaining healthcare utilization. As factors included in the original version of Anderson's expanded behavioral model are expected to affect health through healthcare utilization and factors newly added in the LTC version (which are mainly factors related to informal caregiving) could directly affect the health of the care recipients (Stall et al., 2019), it will be fair to conclude that all of the factors included in LTC version of Anderson's model are confounding covariates. If we assume that all factors affecting LTC use could be captured by the LTC version of Anderson's model, and as they also affect healthcare utilization and health, they are the only possible confounding factors because only the factors affecting both the treatment variable and the dependent variables can cause confounding (Figure 3.1.). Furthermore, these properties can be used as a tool to argue that some of the assumptions of causal mediation analysis can be met, which will be used as a supplemental analysis in Chapter 5.

The remaining question following this approach is whether it is possible to control all the factors included in the LTC version of Anderson's model using variables that can be observed in available data. I would like to argue that a close approximation is possible, using the rich variables available from the NHIS data (Table 3.2). In order to capture the need factor such as degree of disability and

functional health level, age, sex, LTC eligibility score, activities of daily living (ADL)[11], instrumental activities of daily living (IADL)[12], cognition level[13], Charlson comorbidity index (CCI)[14], dementia, diabetes, and hypertension was controlled. To capture the enabling factor such as availability of support and financial resources, income level[15], type of health care coverage[16], LTC eligibility grade, the first year of entering the service, level of LTC facility provision in the region[17], level of rurality[18], presence and type of caregiver and type of cohabitant[19] were controlled. It is difficult to directly capture psychosocial factors such as attitudes, knowledge, social norms, or perceived control using available data. However, I would like to argue that variables such as a number of outpatient visits, inpatient days in the long-term care hospitals, and inpatient days in acute care hospitals before entering LTC services will reveal the tendency of health and long-term care service utilization of each individual, especially when variables measuring health status are also controlled. Moreover, variables such as level of regional

---

[11] ADL was measured by using modified version of Katz index. See appendix 2.1 for details.

[12] IADL was measured by using modified version of Lawton index. See appendix 2.1 for details.

[13] Cognition level was measured using 10 questionnaires used in LTC eligibility assessment. See appendix 2.1 for details.

[14] CCI was measured by following Kim (2010)

[15] Measured by NHI/LTCI contribution level, as contribution of social insurance is set proportional to income

[16] Medicaid beneficiary or not

[17] Basic local government level (Si•Gun•Gu) variable measuring numbers of geriatric hospital beds per 1,000 elderly, numbers of nursing home beds per 1,000 elderly, numbers of home and community base services per 1,000 elderly was used

[18] Basic local government level (Si•Gun•Gu) was controlled. This classification reflects the rurality and development level of the region

[19] Both caregiver type and cohabitant type were categorized into 3 level: alone, close family (spouse, children, or parents), and others.

development or presence and type of caregiver and type of cohabitant are also expected to partly capture such psychosocial factors. As displayed in the literature review in chapter 2 (Table 2.2), most of the previous observational studies on similar topics to this study have not considered such a comprehensive set of covariates, which is one of the advantages of this study.

In this study, two different methods incorporating weights were used to adjust confounding variables: an inverse probability of treatment weighting (IPTW, Hernan & Robins, 2020) and entropy balancing (EB, Hainmueller, 2012). As the goal of both methods is in balancing baseline confounding variables between the treated and control among the weighted population, means and proportions, standard error, and standardized difference of baseline covariates before and after adopting weights were explored and used as balance diagnostics (Austin & Stuart, 2015), and standardized difference smaller than 0.1 was considered balanced (Austin, 2009). Weights calculating average treatment effect (ATE) were used (Austin & Stuart, 2015).

IPTW is one of the methods using propensity score. In controlling observed covariates, propensity score based methods are known to have some advantages over multiple regressions when the focus of the study is on estimating the average effect of the intervention (Hernan & Robins, 2020). Simply put, propensity score can balance measured baseline covariates among the treated and control subjects with a single measure. One strong advantage of this approach is that it reduces the possibility of (outcome) model misspecification. Especially when the treatment variable is binary, a simple linear outcome model based on propensity score analysis is free from model misspecification, as all other covariates are

balanced and the coefficient of the binary variable directly reveals the covariate-adjusted difference between the treated and control (Hernan & Robins, 2020). Among methods incorporating propensity score analysis, IPTW was preferred over matching as propensity score matching (PSM) is known to occur unnecessary imbalance when exact matching is not possible (King & Nielsen, 2019). IPTW uses propensity score to create an artificial population with balanced covariates between the treated and control, by creating a weight as follows. It is known that if the propensity score is adequately estimated, IPTW weighted population achieves the balance of covariates used in estimating the propensity score (Austin & Stuart, 2015).

$$w = \frac{Z}{e} + \frac{1-Z}{1-e} \qquad \cdots\cdots (1)$$ [20]

(Where w is IPTW, e is the probability of a subject receiving the treatment conditional on observed covariates, Z is the treatment assignment)

An important feature that requires attention in applying IPTW is that we do not know the true propensity score, but rather estimate it through a model using observable variables- a treatment model. The most common approach is using logistic regression, but many other more complex models are frequently used in recent literature as logistic regression often fails to achieve the balance of covariates due to treatment model misspecification. In this study, IPTW by estimating propensity score using logistic regression did

[20] Weights for calculating ATE. Weights for average treatment effect on the treated (ATT) could be calculated by multiplying e on w. Details could be found in Austin & Stuart (2015).

improve the balance of covariances but a non-ignorable imbalance remained (Table 2.3). Therefore, two other methods have been considered: IPTW by estimating propensity score using the covariate balancing propensity score (CBPS) method (Imai & Ratcovic, 2014), and EB which directly calculates covariate balancing weights without estimating propensity score (Hainmueller, 2012).

CBPS and EB were considered in this study, especially because they have common strengths in estimating causal effects through weighting (Reshetnyak, 2017). The most important strength of both methods is that they are intended to automatically achieve covariate balance without manual treatment model re-specification. Although a stepwise approach by manually adding interactions or higher order effects of covariates is commonly practiced in the literature (Austin & Stuart, 2015), it requires a repeated process of propensity score estimation and covariate balance check, while CBPS and EB do not. CBPS and EB could also be distinguished from other machine learning based methods such as the generalized boosting model (GBM, McCaffrey et al., 2004), as they do not require tuning parameter and thus process such as cross-validation is not required, which is beneficial in terms of computation time and reproducibility of results.

Although CBPS and EB both employ algorithms that directly aim to balance the measured confounders, these methods have several differences in application. First, while CBPS first estimates the propensity score and uses it to calculate weights, EB calculates covariance balancing weights without estimating the propensity score (Imai & Ratkovic, 2014). This enables CBPS to be applied in other propensity score analyses such as matching. Second, EB

requires to specify the number of moments to be balanced. Vegetabile et al. (2021) suggested that one-moment condition is sufficient when variables are binary, but enforcing two or three moment conditions shows more adequate covariate balances when variables are continuous. Third, CBPS allows for two different identification methods under the generalized methods of moments (GMM) or empirical likelihood (EL) framework, a just-identified CBPS that only uses covariate balancing conditions, or an over-identified CBPS which also combines the score condition of the logistic model (Imai & Ratkovic, 2014). Imai & Ratkovic (2014) suggested that both identification methods performed better than standard logistic regression.

In this study, three different weights were tested for covariate balances: IPTW estimated by standard logistic regression, IPTW estimated by CBPS, and EB weights. An over-identified CBPS was estimated and EB was performed using two-moment conditions. In the final analysis, weighted regression results incorporating EB weights have been reported, as they showed the best covariate balances (Table 3.3)[21]. IPTW analysis based on logistic regression and CBPS has also been investigated as a sensitivity analysis.

To explore the effect modification of initial health status, two different approaches were considered. Although it is commonly accepted to apply a saturated model adding interaction terms of treatment variable and variable of interest to assess effect modification when such variables are included in the controlled baseline covariate set (Hernan & Robins, 2020), this study explored whether the effect of LTC place is modified among

[21] Due to lack of space, covariate balance results for subgroup analysis can be found in appendix 3.2.

subjects with different initial health status by dividing study subjects into subgroups and deriving subgroup specific weights using the divided subgroups. This approach was preferred over using a saturated model as the literature showed that the usual weighting approach may bring biased results when the mechanism beneath treatment assignment is different among the subgroups of interest (Wang et al., 2017), although the results of the saturated model were also investigated as a sensitivity analysis.

As the estimator of the interest, ATE could be simply calculated using the difference of the mean of the weighted population and robust variance estimator is known to produce conservative results (Hernan & Robins, 2020), a weighted least square estimator with the robust standard error was calculated for all analysis throughout this study[22], using the following model (2). Data was handled using SAS enterprise guide 7, and statistical analysis was performed using R 4.0.2. R package *WeightIt*, *CBPS*, and *ebal* were used to estimate weights.

$$E[Y^T] = \beta_0 + \beta_1 T \quad \cdots\cdots \quad (2)$$

(Where $E[Y^T]$ is an expectation of outcome variable Y under treatment level T, and treatment T=1 when the subject is defined as IC user)

[22] Dependent variables used in this chapter are either continuous (but truncated at 0) or binary, and weighted least square estimator was calculated in either case

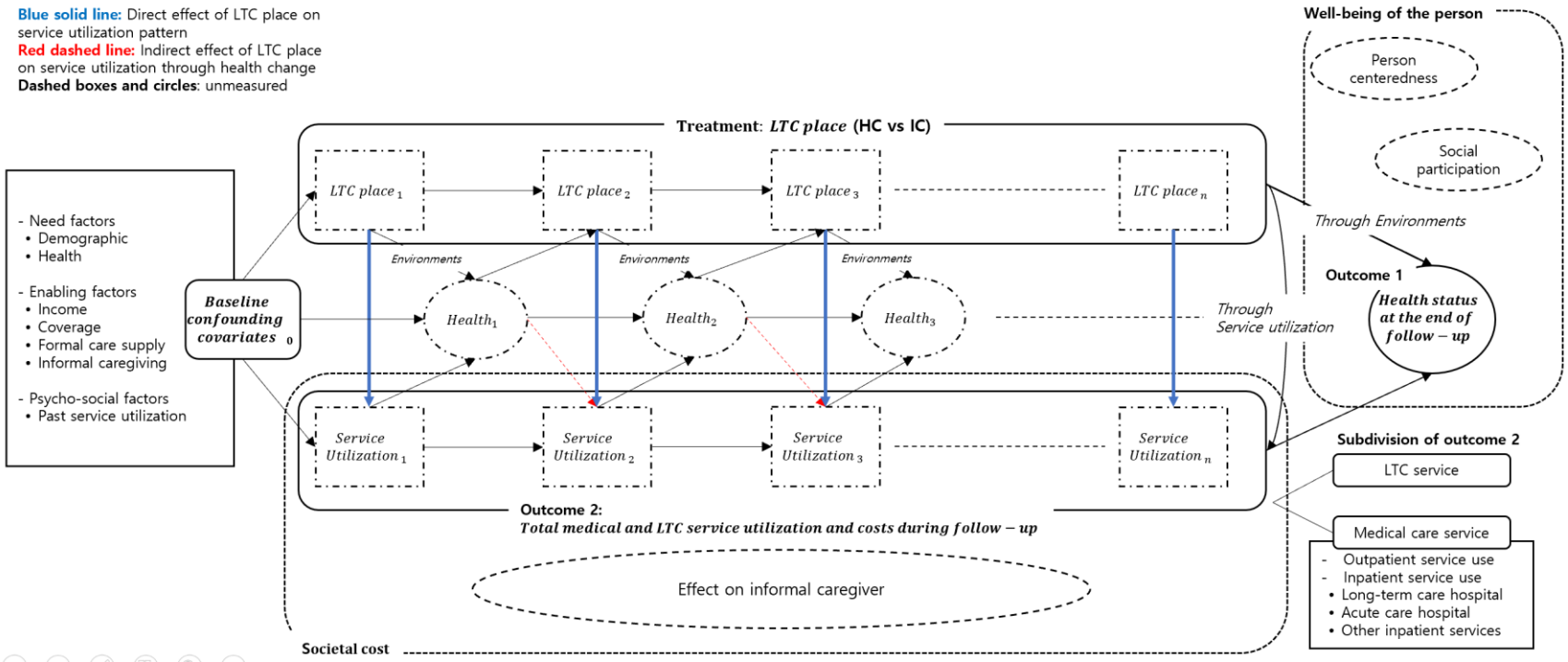


Figure 3.1. Conceptualization of study structure (by author)

* HC: home and community based care; IC: institutional care; LTC: long-term care

[Table 3.1] Baseline characteristics of study sample and subgroups

	Total (n=261,633)	Grade 1−2 (n=21,855)	Grade 3−4 (n=197,735)	Grade 5 (n=42,043)
Age	81.5	81.3	81.5	81.6
Sex (female=1)	65.5%	53.0%	65.5%	71.7%
LTC grade				
1	1.8%	21.6%	−	−
2	6.5%	78.4%	−	−
3	27.5%	−	36,4%	−
4	48.1%	−	63.6%	−
5	16.1%	−	−	100%
LTC eligibility score	59.3	87.0	58.7	47.6
ADL score	3.1	0.7	3.0	4.4
IADL score	3.0	1.3	2.9	4.3
Cognition level	5.8	4.3	5.9	6.2
Disability registration	28.1%	32.3%	29.4%	19.9%
CCI				
0	11.0%	12.9%	12.7%	2.0%
1	24.7%	20.7%	24.5%	27.4%
2	64.3%	66.4%	62.7%	70.6%

* Mean was reported for continuous variables (age, LTC eligibility score, ADL score, IADL score, Cognition level) and proportion was reported for binary and categorical variables (LTC grade, CCI, dementia, disability register)

[Table 3.2] List of adjusted baseline covariates

Factor	Variable	Definition
Need factors	Age	Age at the time of entering LTC service
	Sex	Biological sex
	LTC eligibility score	LTC eligibility score assessed by NHIS
	ADL	Modified version of Katz index, 0−6
	IADL	Modified version of Lawton index, 0−8
	Cognition level	Cognition level, 0−10
	Disability	Registration of disability status
	CCI (0, 1, 2+)	Charlson comorbidity index
	Dementia	Defined based on last 1−year medical records before entering LTC service
	Diabetes	
	Hypertension	
Enabling factors	Income level (1=highest)	Categorized based on quintiles
	Coverage type	Medicaid beneficiary or NHI/LTCI insured
	LTC eligibility grade	Grade 1 to 5
	Entering year	First year of entering formal LTC services
	Regional development	Categorized as big city area (Gu); city area (Si); rural area (Gun)
	Nursing home provision	Number of beds or institutions per 1,000 elderlies, by local government level
	Geriatric hospital provision	
	Homecare provision	
	Cohabitant	None (=1), close family (=2 if spouse, children, or parents), others (=3).
	Caregiver	
Psycho−social factors	Outpatient visits before	Defined based on last 1−year medical records before entering LTC service
	Inpatient days: geriatric	
	Inpatient days: non−geriatric	

* All measured at the baseline−day of applying LTC eligibility assessment, except for income level, coverage type, regional development, nursing home and geriatric hospital provision, which are measured based on the beginning of calendar year of LTC appliance

[Table 3.3] Balance of baseline covariates before and after applying covariate adjusting weights

Treatment 1	No weights			IPTW (logistic model)			IPTW (CBPS)			Entropy balancing weights		
(n=245,751)	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D
1. Continuous												
Eligibility score	65.13(14.24)	58.71(11.34)	0.50	59.73(11.58)	59.35(12.14)	-0.03	59.61(12.24)	59.29(11.84)	-0.02	59.27(11.76)	59.27(11.76)	0.00
ADL	2.53(1.33)	3.11(1.2)	-0.46	3.03(1.25)	3.05(1.23)	0.02	3.02(1.24)	3.06(1.23)	0.03	3.06(1.22)	3.06(1.22)	0.00
IADL	2.38(1.58)	3.06(1.59)	-0.43	2.99(1.65)	3(1.6)	0.00	2.96(1.64)	3(1.6)	0.03	3(1.6)	3(1.6)	0.00
Cognition	4.73(1.99)	5.93(1.99)	0.60	5.65(1.89)	5.81(2.04)	-0.08	5.62(1.89)	5.82(2.03)	-0.10	5.82(2.02)	5.82(2.02)	0.00
Age	83.43(8.53)	81.19(7.84)	0.27	81.44(7.98)	81.39(7.93)	-0.01	81.55(8.09)	81.39(7.92)	-0.02	81.39(7.93)	81.39(7.93)	0.00
IC provision	27.35(13.77)	24.74(13.26)	0.19	25.21(13.03)	24.98(13.41)	-0.02	25.32(13.12)	24.98(13.4)	-0.03	24.97(13.33)	24.97(13.33)	0.00
LH provision	0.19(0.13)	0.21(0.14)	-0.13	0.21(0.15)	0.21(0.14)	0.01	0.21(0.15)	0.21(0.14)	0.01	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.1(0.57)	2.15(0.57)	-0.08	2.15(0.57)	2.14(0.57)	-0.01	2.15(0.57)	2.14(0.57)	0.00	2.14(0.57)	2.14(0.57)	0.00
Outpatient visits	25.41(30.3)	39.96(38.76)	-0.42	53.19(68.44)	38.69(37.87)	-0.42	43.54(56.11)	38.82(37.92)	-0.14	38.7(38.32)	38.7(38.32)	0.00
Inpatient days: total	26.51(60.5)	23.1(48.43)	0.06	24.73(53.07)	23.49(49.92)	-0.02	24.31(52.99)	23.46(49.76)	-0.02	23.4(49.6)	23.4(49.6)	0.00
Inpatient days: LH	11.45(46.24)	5.47(29.2)	0.15	6.18(28.2)	6.06(31.9)	0.00	6.32(28.72)	6.03(31.74)	-0.01	5.99(31.1)	5.99(31.1)	0.00
2. Binary												
Sex (female=1)	0.64(0.48)	0.66(0.47)	-0.04	0.63(0.48)	0.65(0.48)	0.06	0.63(0.48)	0.65(0.48)	0.04	0.65(0.48)	0.65(0.48)	0.00
Medicaid (=1)	0.11(0.31)	0.1(0.3)	0.01	0.11(0.31)	0.1(0.3)	-0.03	0.1(0.31)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.21(0.41)	0.29(0.45)	-0.18	0.29(0.45)	0.29(0.45)	0.00	0.28(0.45)	0.29(0.45)	0.02	0.29(0.45)	0.29(0.45)	0.00
Dementia (=1)	0.28(0.45)	0.09(0.28)	0.51	0.12(0.33)	0.11(0.31)	-0.04	0.12(0.32)	0.11(0.31)	-0.03	0.1(0.31)	0.1(0.31)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.19)	-0.03	0.04(0.19)	0.04(0.19)	0.00	0.04(0.18)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.17)	0.02(0.15)	0.05	0.02(0.14)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.27(0.44)	0.23(0.42)	0.09	0.25(0.43)	0.23(0.42)	-0.03	0.24(0.43)	0.23(0.42)	-0.01	0.23(0.42)	0.23(0.42)	0.00
Income group 2	0.12(0.32)	0.09(0.28)	0.09	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.35)	0.12(0.32)	0.06	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	0.00

Income group 4	0.18(0.39)	0.18(0.38)	0.02	0.17(0.38)	0.18(0.38)	0.02	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.29(0.45)	0.39(0.49)	-0.20	0.37(0.48)	0.38(0.48)	0.01	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Cohabitant 1	0.17(0.37)	0.24(0.43)	-0.17	0.24(0.42)	0.23(0.42)	-0.01	0.23(0.42)	0.23(0.42)	0.01	0.23(0.42)	0.23(0.42)	0.00
Cohabitant 2	0.78(0.42)	0.74(0.44)	0.08	0.74(0.44)	0.75(0.44)	0.01	0.75(0.43)	0.75(0.44)	-0.01	0.75(0.44)	0.75(0.44)	0.00
Cohabitant 3	0.05(0.23)	0.02(0.14)	0.19	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
Caregiver 1	0.04(0.2)	0.05(0.23)	-0.06	0.05(0.22)	0.05(0.22)	0.00	0.05(0.22)	0.05(0.22)	0.01	0.05(0.22)	0.05(0.22)	0.00
Caregiver 2	0.88(0.33)	0.88(0.33)	0.00	0.88(0.33)	0.88(0.33)	0.00	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.08(0.28)	0.07(0.25)	0.05	0.07(0.25)	0.07(0.26)	0.00	0.07(0.25)	0.07(0.26)	0.02	0.07(0.26)	0.07(0.26)	0.00
LTC Grade 1	0.04(0.19)	0.02(0.13)	0.14	0.01(0.11)	0.02(0.14)	0.05	0.02(0.15)	0.02(0.13)	-0.02	0.02(0.13)	0.02(0.13)	0.00
LTC Grade 2	0.17(0.38)	0.05(0.23)	0.38	0.09(0.29)	0.06(0.24)	-0.10	0.07(0.26)	0.07(0.25)	-0.02	0.06(0.25)	0.06(0.25)	0.00
LTC Grade 3	0.36(0.48)	0.27(0.44)	0.20	0.28(0.45)	0.27(0.45)	-0.01	0.27(0.44)	0.27(0.45)	0.01	0.27(0.45)	0.27(0.45)	0.00
LTC Grade 4	0.35(0.48)	0.5(0.5)	-0.31	0.45(0.5)	0.48(0.5)	0.06	0.46(0.5)	0.48(0.5)	0.04	0.48(0.5)	0.48(0.5)	0.00
LTC Grade 5	0.09(0.28)	0.17(0.37)	-0.24	0.16(0.37)	0.16(0.37)	0.00	0.17(0.38)	0.16(0.37)	-0.04	0.16(0.37)	0.16(0.37)	0.00
CCI 0	0.11(0.32)	0.11(0.31)	-0.01	0.10(0.30)	0.11(0.31)	0.04	0.10(0.30)	0.11(0.31)	0.03	0.11(0.31)	0.11(0.31)	0.00
CCI 1	0.31(0.46)	0.24(0.43)	-0.15	0.23(0.42)	0.24(0.43)	0.02	0.24(0.43)	0.24(0.43)	0.00	0.24(0.43)	0.24(0.43)	0.00
CCI 2+	0.58(0.49)	0.65(0.48)	0.14	0.67(0.47)	0.65(0.48)	-0.04	0.66(0.48)	0.65(0.48)	-0.02	0.65(0.48)	0.65(0.48)	0.00
Entrance (=2016)	0.32(0.47)	0.29(0.45)	0.07	0.3(0.46)	0.29(0.45)	-0.03	0.3(0.46)	0.29(0.45)	-0.02	0.29(0.45)	0.29(0.45)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.49)	-0.09	0.37(0.48)	0.38(0.48)	0.02	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Big city area	0.48(0.5)	0.51(0.5)	-0.07	0.51(0.5)	0.51(0.5)	0.01	0.51(0.5)	0.51(0.5)	0.00	0.51(0.5)	0.51(0.5)	0.00
City area	0.34(0.48)	0.31(0.46)	0.07	0.18(0.38)	0.18(0.38)	0.00	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.18(0.38)	0.18(0.38)	0.00	0.32(0.47)	0.31(0.46)	-0.01	0.32(0.47)	0.31(0.46)	-0.01	0.31(0.46)	0.31(0.46)	0.00
Treatment 2	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=261,633)	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D
1. Continuous												
Eligibility score	65.13(14.24)	58.78(11.37)	-0.49	59.78(11.57)	59.36(12.08)	-0.03	59.64(12.19)	59.32(11.83)	-0.02	59.3(11.76)	59.3(11.76)	0.00

ADL	2.53(1.33)	3.1(1.2)	0.45	3.03(1.25)	3.05(1.23)	0.02	3.01(1.24)	3.05(1.23)	0.03	3.05(1.22)	3.05(1.22)	0.00
IADL	2.38(1.58)	3.04(1.59)	0.42	2.98(1.65)	2.99(1.6)	0.00	2.95(1.64)	2.99(1.6)	0.03	2.99(1.6)	2.99(1.6)	0.00
Cognition	4.73(1.99)	5.88(1.99)	-0.57	5.61(1.89)	5.78(2.03)	-0.08	5.59(1.89)	5.78(2.03)	-0.10	5.78(2.02)	5.78(2.02)	0.00
Age	83.43(8.53)	81.32(7.84)	-0.26	81.56(7.96)	81.49(7.91)	-0.01	81.66(8.06)	81.49(7.91)	-0.02	81.49(7.92)	81.49(7.92)	0.00
IC provision	27.35(13.77)	24.92(13.29)	-0.18	25.38(13.08)	25.12(13.41)	-0.02	25.48(13.17)	25.12(13.41)	-0.03	25.12(13.35)	25.12(13.35)	0.00
LH provision	0.19(0.13)	0.21(0.14)	0.12	0.21(0.14)	0.21(0.14)	0.01	0.21(0.14)	0.21(0.14)	0.01	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.1(0.57)	2.15(0.57)	0.08	2.15(0.57)	2.14(0.57)	-0.01	2.15(0.57)	2.14(0.57)	0.00	2.14(0.57)	2.14(0.57)	0.00
Outpatient visits	25.41(30.3)	39.38(38.47)	0.40	51.08(65.91)	38.24(37.65)	-0.37	42.48(54.68)	38.35(37.7)	-0.12	38.24(38.06)	38.24(38.06)	0.00
Inpatient days: total	26.51(60.5)	22.59(47.82)	-0.07	23.96(51.67)	22.98(49.25)	-0.02	23.65(51.8)	22.95(49.1)	-0.01	22.91(48.99)	22.91(48.99)	0.00
Inpatient days: LH	11.45(46.24)	5.39(28.92)	-0.16	6.09(27.93)	5.93(31.42)	0.00	6.22(28.43)	5.9(31.27)	-0.01	5.88(30.74)	5.88(30.75)	0.00
2. Binary												
Sex (female=1)	0.64(0.48)	0.66(0.47)	0.04	0.63(0.48)	0.65(0.48)	0.05	0.63(0.48)	0.65(0.48)	0.04	0.65(0.48)	0.65(0.48)	0.00
Medicaid (=1)	0.11(0.31)	0.1(0.3)	-0.02	0.11(0.31)	0.1(0.3)	-0.02	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.21(0.41)	0.29(0.45)	0.17	0.28(0.45)	0.28(0.45)	0.00	0.27(0.45)	0.28(0.45)	0.02	0.28(0.45)	0.28(0.45)	0.00
Dementia (=1)	0.28(0.45)	0.09(0.29)	-0.49	0.13(0.33)	0.11(0.31)	-0.04	0.12(0.33)	0.11(0.31)	-0.03	0.11(0.31)	0.11(0.31)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.19)	0.03	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.17)	0.02(0.15)	-0.05	0.02(0.15)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.27(0.44)	0.23(0.42)	-0.09	0.24(0.43)	0.23(0.42)	-0.02	0.24(0.43)	0.23(0.42)	-0.01	0.23(0.42)	0.23(0.42)	0.00
Income group 2	0.12(0.32)	0.09(0.29)	-0.09	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	-0.01	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.35)	0.12(0.33)	-0.06	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	0.00
Income group 4	0.18(0.39)	0.18(0.38)	-0.01	0.17(0.38)	0.18(0.38)	0.01	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.29(0.45)	0.38(0.49)	0.20	0.37(0.48)	0.38(0.48)	0.01	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Cohabitant 1	0.17(0.37)	0.23(0.42)	0.16	0.23(0.42)	0.23(0.42)	-0.01	0.22(0.42)	0.23(0.42)	0.01	0.23(0.42)	0.23(0.42)	0.00
Cohabitant 2	0.78(0.42)	0.75(0.44)	-0.07	0.74(0.44)	0.75(0.43)	0.01	0.75(0.43)	0.75(0.43)	-0.01	0.75(0.43)	0.75(0.43)	0.00
Cohabitant 3	0.05(0.23)	0.02(0.14)	-0.19	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00

Caregiver 1	0.04(0.2)	0.05(0.22)	0.06	0.05(0.22)	0.05(0.22)	0.00	0.05(0.22)	0.05(0.22)	0.01	0.05(0.22)	0.05(0.22)	0.00
Caregiver 2	0.88(0.33)	0.88(0.33)	0.01	0.88(0.32)	0.88(0.33)	-0.01	0.89(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.08(0.28)	0.07(0.25)	-0.06	0.07(0.25)	0.07(0.25)	0.01	0.06(0.24)	0.07(0.25)	0.02	0.07(0.25)	0.07(0.25)	0.00
LTC Grade 1	0.04(0.19)	0.02(0.13)	-0.14	0.01(0.11)	0.02(0.14)	0.05	0.02(0.15)	0.02(0.13)	-0.02	0.02(0.13)	0.02(0.13)	0.00
LTC Grade 2	0.17(0.38)	0.06(0.23)	-0.37	0.09(0.29)	0.06(0.24)	-0.10	0.07(0.26)	0.07(0.25)	-0.02	0.07(0.25)	0.07(0.25)	0.00
LTC Grade 3	0.36(0.48)	0.27(0.44)	-0.20	0.28(0.45)	0.27(0.45)	-0.01	0.27(0.44)	0.27(0.45)	0.01	0.28(0.45)	0.28(0.45)	0.00
LTC Grade 4	0.35(0.48)	0.49(0.5)	0.30	0.45(0.5)	0.48(0.5)	0.06	0.46(0.5)	0.48(0.5)	0.04	0.48(0.5)	0.48(0.5)	0.00
LTC Grade 5	0.09(0.28)	0.17(0.37)	0.25	0.16(0.37)	0.16(0.37)	0.01	0.17(0.38)	0.16(0.37)	-0.04	0.16(0.37)	0.16(0.37)	0.00
CCI 0	0.11(0.30)	0.11(0.31)	0.00	0.10(0.30)	0.11(0.31)	0.03	0.10(0.30)	0.11(0.31)	0.02	0.11(0.31)	0.11(0.31)	0.00
CCI 1	0.30(0.46)	0.24(0.43)	-0.14	0.24(0.43)	0.25(0.43)	0.02	0.25(0.46)	0.25(0.43)	0.00	0.25(0.43)	0.25(0.43)	0.00
CCI 2+	0.59(0.49)	0.65(0.48)	0.13	0.66(0.47)	0.64(0.48)	-0.04	0.65(0.49)	0.64(0.48)	-0.02	0.64(0.48)	0.64(0.48)	0.00
Entrance (=2016)	0.32(0.47)	0.29(0.45)	-0.07	0.31(0.46)	0.29(0.45)	-0.03	0.3(0.46)	0.29(0.45)	-0.02	0.29(0.45)	0.29(0.45)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	-0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.49)	0.09	0.37(0.48)	0.38(0.48)	0.02	0.37(0.48)	0.38(0.48)	0.02	0.38(0.48)	0.38(0.48)	0.00
Big city area	0.48(0.5)	0.51(0.5)	0.06	0.5(0.5)	0.51(0.5)	0.01	0.51(0.5)	0.51(0.5)	0.00	0.51(0.5)	0.51(0.5)	0.00
City area	0.18(0.38)	0.18(0.38)	0.00	0.18(0.38)	0.18(0.38)	0.00	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.34(0.48)	0.31(0.46)	-0.06	0.32(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.46)	-0.01	0.32(0.47)	0.32(0.47)	0.00
Treatment 3	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=261,633)	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D	IC group	HC group	S.D
1. Continuous												
Eligibility score	62.87(13.47)	58.71(11.34)	0.33	59.55(11.71)	59.37(12.08)	-0.01	59.57(12.16)	59.32(11.83)	-0.02	59.3(11.76)	59.3(11.76)	0.00
ADL	2.73(1.31)	3.11(1.2)	-0.30	3.04(1.25)	3.05(1.23)	0.01	3.02(1.24)	3.05(1.23)	0.03	3.05(1.22)	3.05(1.22)	0.00
IADL	2.58(1.62)	3.06(1.59)	-0.30	2.97(1.63)	2.99(1.6)	0.01	2.95(1.62)	2.99(1.6)	0.02	2.99(1.6)	2.99(1.6)	0.00
Cognition	4.91(1.96)	5.93(1.99)	0.51	5.66(1.9)	5.77(2.04)	-0.06	5.62(1.9)	5.78(2.04)	-0.08	5.78(2.02)	5.78(2.02)	0.00
Age	83.29(8.12)	81.19(7.84)	0.26	81.65(7.89)	81.5(7.91)	-0.02	81.75(7.93)	81.49(7.91)	-0.03	81.49(7.92)	81.49(7.92)	0.00
IC provision	27.37(13.65)	24.74(13.26)	0.20	25.41(12.93)	25.13(13.48)	-0.02	25.5(12.99)	25.13(13.47)	-0.03	25.12(13.35)	25.12(13.35)	0.00

LH provision	0.19(0.13)	0.21(0.14)	-0.12	0.21(0.14)	0.21(0.14)	0.01	0.21(0.14)	0.21(0.14)	0.01	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.12(0.57)	2.15(0.57)	-0.05	2.15(0.57)	2.14(0.57)	-0.01	2.15(0.57)	2.14(0.57)	-0.01	2.14(0.57)	2.14(0.57)	0.00
Outpatient visits	27.87(31.61)	39.96(38.76)	-0.34	43.78(55.36)	38.26(37.42)	-0.16	39.56(48.51)	38.42(37.52)	-0.03	38.24(38.06)	38.24(38.06)	0.00
Inpatient days: total	21.75(52.26)	23.1(48.43)	-0.03	23.98(53.5)	22.95(48.99)	-0.02	23.03(52.08)	22.99(48.99)	0.00	22.91(48.99)	22.91(48.99)	0.00
Inpatient days: LH	8.38(38.66)	5.47(29.2)	0.09	5.81(28.42)	5.9(31.26)	0.00	5.78(28.49)	5.9(31.24)	0.00	5.88(30.74)	5.88(30.75)	0.00
2. Binary												
Sex (female=1)	0.64(0.48)	0.66(0.47)	-0.03	0.64(0.48)	0.65(0.48)	0.03	0.64(0.48)	0.65(0.48)	0.02	0.65(0.48)	0.65(0.48)	0.00
Medicaid (=1)	0.09(0.29)	0.1(0.3)	-0.04	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.01	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.22(0.41)	0.29(0.45)	-0.18	0.27(0.45)	0.28(0.45)	0.02	0.27(0.44)	0.28(0.45)	0.03	0.28(0.45)	0.28(0.45)	0.00
Dementia (=1)	0.24(0.43)	0.09(0.28)	0.42	0.12(0.32)	0.11(0.31)	-0.02	0.12(0.32)	0.11(0.31)	-0.02	0.11(0.31)	0.11(0.31)	0.00
Diabetes (=1)	0.03(0.18)	0.04(0.19)	-0.02	0.04(0.19)	0.04(0.19)	0.00	0.04(0.18)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.17)	0.02(0.15)	0.05	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.25(0.43)	0.23(0.42)	0.05	0.24(0.42)	0.23(0.42)	0.00	0.23(0.42)	0.23(0.42)	0.00	0.23(0.42)	0.23(0.42)	0.00
Income group 2	0.11(0.32)	0.09(0.28)	0.08	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.34)	0.12(0.32)	0.05	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	-0.01	0.12(0.33)	0.12(0.33)	0.00
Income group 4	0.18(0.39)	0.18(0.38)	0.02	0.17(0.38)	0.18(0.38)	0.00	0.17(0.38)	0.18(0.38)	0.00	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.32(0.47)	0.39(0.49)	-0.14	0.38(0.48)	0.38(0.48)	0.00	0.38(0.48)	0.38(0.48)	0.00	0.38(0.48)	0.38(0.48)	0.00
Cohabitant 1	0.18(0.39)	0.24(0.43)	-0.13	0.23(0.42)	0.23(0.42)	0.00	0.22(0.42)	0.23(0.42)	0.01	0.23(0.42)	0.23(0.42)	0.00
Cohabitant 2	0.78(0.42)	0.74(0.44)	0.08	0.75(0.43)	0.75(0.43)	0.00	0.75(0.43)	0.75(0.43)	-0.01	0.75(0.43)	0.75(0.43)	0.00
Cohabitant 3	0.04(0.2)	0.02(0.14)	0.12	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
Caregiver 1	0.04(0.2)	0.05(0.23)	-0.05	0.05(0.22)	0.05(0.22)	0.00	0.05(0.22)	0.05(0.22)	0.01	0.05(0.22)	0.05(0.22)	0.00
Caregiver 2	0.89(0.31)	0.88(0.33)	0.04	0.88(0.32)	0.88(0.33)	0.00	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.07(0.25)	0.07(0.25)	0.00	0.07(0.25)	0.07(0.25)	0.00	0.07(0.25)	0.07(0.25)	0.01	0.07(0.25)	0.07(0.25)	0.00
LTC Grade 1	0.03(0.17)	0.02(0.13)	0.09	0.01(0.12)	0.02(0.14)	0.04	0.02(0.15)	0.02(0.13)	-0.02	0.02(0.13)	0.02(0.13)	0.00
LTC Grade 2	0.13(0.34)	0.05(0.23)	0.27	0.09(0.28)	0.06(0.24)	-0.09	0.07(0.26)	0.07(0.25)	-0.01	0.07(0.25)	0.07(0.25)	0.00

LTC Grade 3	0.33(0.47)	0.27(0.44)	0.14	0.27(0.45)	0.27(0.45)	0.00	0.27(0.44)	0.27(0.45)	0.01	0.28(0.45)	0.28(0.45)	0.00
LTC Grade 4	0.38(0.49)	0.5(0.5)	-0.23	0.45(0.5)	0.48(0.5)	0.07	0.46(0.5)	0.48(0.5)	0.04	0.48(0.5)	0.48(0.5)	0.00
LTC Grade 5	0.12(0.33)	0.17(0.37)	-0.13	0.18(0.38)	0.16(0.37)	-0.04	0.17(0.38)	0.16(0.37)	-0.04	0.16(0.37)	0.16(0.37)	0.00
CCI 0	0.11(0.32)	0.11(0.31)	-0.01	0.10(0.30)	0.11(0.31)	0.04	0.10(0.30)	0.11(0.31)	0.03	0.11(0.31)	0.11(0.31)	0.00
CCI 1	0.31(0.46)	0.24(0.43)	-0.14	0.24(0.43)	0.25(0.43)	0.02	0.25(0.43)	0.25(0.43)	0.00	0.25(0.43)	0.25(0.43)	0.00
CCI 2+	0.58(0.49)	0.65(0.48)	0.14	0.66(0.47)	0.64(0.48)	-0.04	0.65(0.48)	0.64(0.48)	-0.02	0.64(0.48)	0.64(0.48)	0.00
Entrance (=2016)	0.32(0.46)	0.29(0.45)	0.06	0.29(0.46)	0.29(0.45)	-0.01	0.3(0.46)	0.29(0.45)	-0.01	0.29(0.45)	0.29(0.45)	0.00
Entrance (=2017)	0.34(0.48)	0.33(0.47)	0.03	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.49)	-0.09	0.37(0.48)	0.38(0.48)	0.01	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Big city area	0.47(0.5)	0.51(0.5)	-0.08	0.5(0.5)	0.51(0.5)	0.01	0.5(0.5)	0.51(0.5)	0.01	0.51(0.5)	0.51(0.5)	0.00
City area	0.35(0.48)	0.31(0.46)	0.08	0.18(0.38)	0.18(0.38)	-0.01	0.18(0.38)	0.18(0.38)	0.00	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.18(0.38)	0.18(0.38)	0.01	0.32(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.47)	0.00

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow-up period) were treated as IC group

* IPTW: Inverse probability of treatment weighting; CBPS: Covariate balancing propensity score; ADL: Activities of daily living; IADL: Instrumental activities of daily living; LH: Long-term care hospital; CCI: Charlson comorbidity index

* Mean (standard error) was reported for continuous variables and proportion (standard error) was reported for binary and categorical variables

References

Andersen, R., & Newman, J. F. (2005). Societal and individual determinants of medical care utilization in the United States. The Milbank Quarterly, 83(4).

Austin, P. C. (2009). Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. Statistics in medicine, 28(25), 3083-3107.

Austin, P. C., & Stuart, E. A. (2015). Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. Statistics in medicine, 34(28), 3661-3679.

Baiocchi, M., Cheng, J., & Small, D. S. (2014). Instrumental variable methods for causal inference. Statistics in medicine, 33(13), 2297-2340.

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020, Sep). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. Journal of Health Economics, 73, Article 102354. https://doi.org/10.1016/j.jhealeco.2020.102354

Beard, J. R., Officer, A., De Carvalho, I. A., Sadana, R., Pot, A. M., Michel, J.-P., Lloyd-Sherlock, P., Epping-Jordan, J. E., Peeters, G. G., & Mahanani, W. R. (2016). The World report on ageing and health: a policy framework for healthy ageing. The lancet, 387(10033), 2145-2154.

Hainmueller, J. (2012). Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. Political analysis, 20(1), 25-46.

Han, E., Kwak, M., & Kang, I. (2011). A Determining System for the Category of Need in Long-Term Care Insurance System using Decision Tree Model. The Korean Journal of Applied Statistics, 24(1), 15.

Hernan, M. A., & Robins, J. M. (2020). Causal inference: What if. CRC Press.

Imai, K., & Ratkovic, M. (2014). Covariate balancing propensity score. Journal of the Royal Statistical Society: Series B (Statistical Methodology), 76(1), 243-263.

Kim, H., & Kwon, S. (2021). A decade of public long-term care insurance in South Korea: Policy lessons for aging countries. Health Policy, 125(1), 22-26.

Kim, H. B., & Lim, W. (2015). Long-term care insurance, informal care, and medical expenditures. Journal of Public Economics, 125, 128-142.

Kim, K. (2010). Comparative study on three algorithms of the ICD-10 Charson Commorbidity Index with Myocardial Infarction patients. Journal of Preventive Medicine and Public Health, 43(1), 42-49.

King, G., & Nielsen, R. (2019). Why propensity scores should not be used for matching. Political analysis, 27(4), 435-454.

Krieger, N. (1994). Epidemiology and the web of causation: has anyone seen the spider? Social Science & Medicine, 39(7), 887-903.

Kuzuya, M., Enoki, H., Hasegawa, J., Izawa, S., Hirakawa, Y., Shimokata, H., & Akihisa, I. (2011). Impact of caregiver burden on adverse health outcomes in community-dwelling dependent older care recipients. The American Journal of Geriatric Psychiatry, 19(4), 382-391.

Lordos, E. F., Herrmann, F. R., Robine, J.-M., Balahoczky, M., Giannelli, S. V., Gold, G., & Michel, J.-P. (2008). Comparative value of medical diagnosis versus physical functioning in predicting the 6-year survival of 1951 hospitalized old patients. Rejuvenation research, 11(4), 829-836.

Marmot, M. (2005). Social determinants of health inequalities. The lancet, 365(9464), 1099-1104.

McCaffrey, D. F., Griffin, B. A., Almirall, D., Slaughter, M. E., Ramchand, R., & Burgette, L. F. (2013). A tutorial on propensity score estimation for multiple treatments using generalized boosted models. Statistics in medicine, 32(19), 3388-3414.

NHIS. (2022). 2021 Long term care insurance statistical yearbook. National Health Insurance Service.

Reshetnyak, E. (2017). Systematic Evaluation and Comparison of Entropy Balancing and Covariate Balancing Propensity Score Methods. Fordham University. [Doctoral Dissertation].

Stall, N. M., Kim, S. J., Hardacre, K. A., Shah, P. S., Straus, S. E., Bronskill, S. E., Lix, L. M., Bell, C. M., & Rochon, P. A. (2019). Association of informal caregiver distress with health outcomes of community-dwelling dementia care recipients: a systematic review. Journal of the American Geriatrics Society, 67(3), 609-617.

Travers, J. L., Hirschman, K. B., & Naylor, M. D. (2020). Adapting Andersen's expanded behavioral model of health services use to include older adults receiving long-term services and supports. Bmc Geriatrics,

20(1), 1-16.

Vegetabile, B. G., Griffin, B. A., Coffman, D. L., Cefalu, M., Robbins, M. W., & McCaffrey, D. F. (2021). Nonparametric estimation of population average dose-response curves using entropy balancing weights for continuous exposures. Health Services and Outcomes Research Methodology, 21(1), 69-110.

Wang, S. V., He, M., Jin, Y., Wyss, R., Shin, H., Ma, Y., Keeton, S., Fireman, B., Karami, S., & Major, J. M. (2017). A review of the performance of different methods for propensity score matched subgroup analyses and a summary of their application in peer-reviewed research studies. Pharmacoepidemiology and Drug Safety, 26(12), 1507-1512.

Werner, R. M., Coe, N. B., Qi, M., & Konetzka, R. T. (2019). Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA internal medicine, 179(5), 617-623.

WHO. (2015). World report on ageing and health. World Health Organization.

Yun, S., & Lee, T.-j. (2022). Analyzing the effect of the policy easing the economic burden of visiting nursing services for dementia patients. The Korean Journal of Health Economics and Policy, 28(2), 25-48.

Chapter 4. Can the place of receiving long-term care affect health?

4.1 Conceptual framework

Although there exist various types of long-term care services in order to serve the needs of the elderly, the concept of place- whether one is residing where he or she lived or is admitted to an institutional care service (IC) was focused on in this study. I would like to argue that admission to an IC facility cannot be seen as simply a type of long-term care service, but it is a migration alienating one with their prior social capital and changing the ways of life they have been enjoying.

This distinction is also important because it can reveal the fundamental philosophy underlining the long-term care policy in the era of population ageing- deinstitutionalization of long-term care. LTC deinstitutionalization seems to be a policy direction applied in many countries, based on the notion that user preferences and quality of life is generally higher at home and community based care (HC) environment and they are also deemed less expensive (Guo et al., 2015; Norton, 2016), although empirical evidence is inconclusive (Konetzka, 2014; Wysocki et al., 2015; Young et al., 2017).

In this chapter of the study, I would like to focus on the fact that the health or functional capability of the aged individual takes an important position in their overall quality of life (Coast et al.,

2008; Couzner et al., 2012), especially when we consider health as a broader concept moving beyond mortality and clinical diseases. I will follow the notion of WHO's public health framework for healthy ageing (WHO, 2015) while defining the health of the study subjects – an aged population who are eligible for long-term care services. WHO's framework defines healthy ageing as maximizing the functional ability of an individual, and emphasizes that not only intrinsic (health) capacity affects such functional ability but the interaction with supportive environments also plays an important role (Beard et al., 2016), which is why ADL, IADL, and cognitive capacity have been used as a primary outcome variable of this study, along with death.

The World report on ageing and health suggests that maximizing the functional ability of an individual can be achieved in two ways: through building and maintaining intrinsic health capacity, and through building an enabling environment and support (Beard et al., 2016). On this behalf, four priority areas were identified in achieving healthy ageing of the population: well-aligned health system to serve the needs of the older population, proper long-term care systems, an age-friendly environment, and improved understanding through measurement and monitoring (Beard et al., 2016). I would like to suggest that the place of receiving long-term care could differently affect health through such areas (Figure 4.1.).

It seems apparent that moving into an IC facility means a change in physical and psychosocial environment, which also include disconnection from one's usual source of health care. As suggested by WHO's framework, these are the priority factors affecting the health of later life, and moving into an IC facility seems likely to change these factors in a way that is unfavorable to health.

For example, alienation from usual social interactions can have a negative effect on mental health (Almedom, 2005; McKenzie et al., 2002). Moreover, as most IC facilities are operated based on the multi-bed rooms in Korea (NHIS, 2022), private space is limited both in physical and social terms. Research conducted in Korea targeting severely disabled dementia patients has shown that those in IC environments experience more hip fractures (Kim et al., 2019), suggesting limited physical environments may have a negative effect on physical health. Limitations of private space and autonomy could also deteriorate mental health (Radden, 2012). Disconnection with the usual source of health care might also have a negative effect on health, especially by discontinuity of prevention and management of chronic health conditions (Ettner, 1999; Starfield, 1994; Weiss & Blustein, 1996).

The negative effect of moving into an IC facility on health may be attenuated among those with more severe initial health status, which is not often discussed in the literature (Wysocki et al., 2015; Young et al., 2017). For those with severe health conditions, the effects of physical or psychosocial environments and the usual source of health care might be small as they are already too frail to benefit from preventive or health promoting activities. Moreover, the presence of 24 hours rotating nursing staff mandated in IC facilities could benefit those with advanced chronic conditions—the severe ones, by meeting parts of the unmet needs for care (Depalma et al., 2013; Gaugler et al., 2005). Taken together, even if it is true that most of the factors related to IC service are expected to be detrimental to health, the size of the effect may be smaller for the severe ones.

This chapter of the study intends to explore and address two

specific issues which are seldom studied in the literature. First, the effect of LTC place on health and whether this effect is different according to initial health status will be explored. This is especially important as initial health statuses such as ADL or diagnostic conditions are commonly used as a criterion for determining eligibility to use IC services (Colombo et al., 2011). Second, analysis using conditions such as depression, hip fracture experience, preventable hospitalization, and appropriate or inappropriate emergency room visit as the dependent variable was also performed, to explore whether the assumed channels underlying the relations between LTC place and health are appropriate. This analysis will allow us to better understand the underlying mechanism of how LTC place affects health, presenting a point where existing LTC services can be supplemented.

4.2 Measurement of dependent variables

Two groups of dependent variables were used in this study. The first group of variables was intended to measure the 'health status' of LTC recipients after 1 year of follow-up: death within 1 year, ADL after 1 year, IADL after 1 year, and cognition level after 1 year was used[23]. ADL was measured by a modified version of Katz index, IADL was measured by a modified version of Lawton index, and cognition level was been scored on as 0 to 10 scale using 10 questionnaires asked during the LTC eligibility assessment. Measuring ADL, IADL, and cognition level after 1 year of entering LTC service was available as all the beneficiaries first entering the formal LTC scheme should be reassessed after 1 year of acquiring LTC eligibility in order to renew the eligibility status. However, as subjects who died during the 1 year follow-up period were unavailable to receive reassessment, ADL, IADL, and cognition level scores after 1 year of acquiring LTC eligibility were treated as 0 – meaning they have lost all their functional abilities and capacities. Even after treating the loss of follow-up due to death, there still remained 2.7% (6,994 subjects) of subjects who did not receive reassessment after 1 year of acquiring LTC eligibility. As those who did not receive reassessment could be considered missing not at random (MNAR) since they are typically those who decided not to use formal LTC services anymore and this decision may be related to both LTC place and health status, simply removing the subjects with missing values may cause bias. In this study, two sets of sensitivity analyses treating the subjects with

[23] See appendix 3.1 for questionnaires and scoring procedures for ADL, IADL, and cognition level.

missing values differently had been performed to deal with this problem. First, analysis based on a positive scenario assumed that the ADL, IADL, and cognition levels of subjects with missing values stayed at the same initial level during follow-up. Second, analysis based on a negative scenario assumed that the ADL, IADL, and cognition levels of subjects with missing values dropped to 0 after 1 year of follow-up.

The second group of variables was intended to explore the underlying channels in which the place of receiving long-term care affects health, and was measured based on medical claim data of each subject: hospitalization experience due to ambulatory care sensitive conditions (ACSC, Jeong et al., 2016) within 1 year, hospitalization experience due to hip fracture within 1 year[24], health care utilization due to depression within 1 year[25], ER visits leading to death within the episode or transporting the patient back without treatment (inappropriate ER visits), and ER visits which required in-hospital treatment (appropriate ER visits) were used, and all variables were treated binary. Hospitalization experience due to ACSC was intended to measure continuity of care and minimizing of preventable hospitalization due to primary care sensitive conditions. Hospitalization experience due to fracture and health care utilization due to depression were intended to measure physical and psychosocial environments. Appropriate and inappropriate ER visits were intended to measure the influence of 24 hours rotating nursing staff which are only available in IC conditions.

---

[24] Defined as patients who had hospitalization experience with hip fracture codes (S72.0, S72.1, S72.2) as main symptoms.

[25] Defined as patients who had medical service utilization with depression codes (F32) as main symptoms, and medications such as SSRI/SNRIs, TCAs, or MAOs were prescribed.

The results of this chapter are derived from the following regression applying weighted least square incorporating covariate balancing weights derived from chapter 2, and the robust standard error has been reported.

$$E[Y^T] = \beta_0 + \beta_1 T$$

(Where $E[Y^T]$ is an expectation of outcome variable Y under treatment level T, and treatment T=1 when the subject is defined as IC user)

4.3 Results

Effect of LTC place on health

Results of weighted regression adjusting baseline covariates show that in general, LTC institutionalization deteriorates health regardless of initial health status, although the intent of deterioration diminished for those with worse initial health status (Table 4.1). This result was in general robust regardless of how the switch users were treated, although in the analysis of treating all switch users as IC users (treatment 3), the severest samples (grade 1-2) showed no statistical difference in health effects between IC users and HC users.

Among the moderately disabled samples (grade 3-4) who consists of the majority of the study population, IC users were at about 5%p higher risk of dying, lost 0.5 points more ADL and IADL scores, and lost 0.8 points more cognition within 1 year compared to HC users. This effect was generally higher among those with the mildest initial health status (grade 5), as they showed about 5%p higher risk of dying, and lost 0.9 points more ADL, IADL, and cognition scores. The size of the health deteriorating impact of IC services was relatively small among the severest samples (grade 1-2), showing about 3%p higher risk of dying, losing 0.05, 0.08, and 0.2 more points of ADL, IADL, and cognition scores respectively. Sensitivity analysis using the full sample to apply a saturated model adding interaction terms of severity and the treatment variable showed similar results (Appendix 4.1).

Results were robust to other sensitivity analyses, which adopted different covariate adjusting weights (Appendix 4.2),

applying other strategies in measuring the treatment variable by using the ITT approach or operational definition approach (Appendix 4.3), analysis applying positive and negative scenarios in treating missing value observations (Appendix 4.4), and analysis using dementia as a criterion for determining severity (Appendix 4.5). In general, all sensitivity analysis results showed similar implications with the main analysis, except for a few cases where IC services showed no statistical difference in health effects among the severest samples (grade 1-2). One case where the operational definition approach (treatment 5) was applied has shown that IC service may reduce 2.8%p risk of dying within a year (Appendix 4.3). As the operational definition approach treats the switch user who has utilized IC service more than half of the observed period as an IC user, they could over-include survivors by definition and cause selection bias, and therefore, this sensitivity analysis result should be interpreted with caution. Overall, results suggest that even after adjusting extensive sets of baseline covariates, IC services deteriorate health compared to HC services, especially among the less severe ones.

How can LTC place affect health?

An analysis involving a set of dependent variables including depression, fractures, preventable hospitalization, and emergency room visits was conducted to empirically identify channels assumed to mediate the health impact of LTC institutionalization. Results of weighted regressions adjusting baseline covariates suggest that assumed channels such as psychosocial and physical environments, and access to preventable health care services are generally better

among HC users, and 24 hours nursing staff existence in IC service did play a role (Table 4.2). Moreover, the health effects of these channels also seem to vary by the initial health status of the patient, although the extent of effect modification is less clear compared to the results capturing general health effects explained earlier.

Among the moderately dependent samples (grade 3-4) consisting majority of the study population, IC users were at about 0.6%p higher risk of depression, 1.4%p higher risk of experiencing a hip fracture, 5.4%p higher risk of experiencing preventable hospitalization, 1.6%p higher risk of inappropriate ER visits, and 3.3%p higher chance of appropriate ER visits. Effects of IC services on hip fracture, preventable hospitalization experience, inappropriate ER visits, and appropriate ER visit was higher among those with the mildest initial health status (grade 5), as IC users were in 3.9%p, 9.5%p, 2.7%p, and 6.6%p higher chance compared to HC users, respectively. The severest samples (grade 1-2) showed a rather similar effect size compared to the moderately disabled samples (grade 3-4), as IC users in these samples were at about 0.7%p higher risk of depression, 1.1%p higher risk of experiencing a hip fracture, and 6.2%p higher risk of experiencing preventable hospitalization, although the effect on depression was statistically insignificant. The effect of IC on depression was also statistically insignificant among those with the mildest initial health status (grade 5), which may be due to the fact that depression was measured by the experience of receiving medical care due to depression while a high proportion of the severest samples (grade 1-2) and grade 5 patients who are cognitively impaired may receive less medical care due to emotional problems.

The severest samples (grade 1-2) showed an interesting

result in terms of experiencing an ER visit, as the IC users showed 1.6%p lower risk on inappropriate ER visits while having 2.1%p higher chance of appropriate ER visit, although the effect on inappropriate ER visits was statistically insignificant in several sensitivity analysis results. Results show that in general, IC users experience more frequent ER visits compared to HC users regardless of initial health status, but experiencing inappropriate ER visits was only more frequent in IC users among less severe samples. Although it is hard to identify whether the result that IC user experiences more frequent appropriate ER visits are the effect of 24 hours rotating nursing staff or due to health outcome differences, the fact that the severest IC user tends to experience less frequent inappropriate ER visits while the less severe IC user experienced more frequent inappropriate ER visits attracts some attention. Considering the fact that the health outcomes of IC users are worse than HC users, less frequent inappropriate ER visits among severest IC users may imply a systematic difference in care between IC and HC users. IC users may experience less frequent inappropriate ER visits because it is difficult for informal care providers in the HC environment to identify and provide care for mild conditions, whereas identification and care for mild conditions are available in IC environments by 24 hours rotating nursing staff.

Results were robust to other sensitivity analyses, which applied a saturated model adding interaction terms of severity and the treatment variable (Appendix 4.6), adopting different covariate adjusting weights (Appendix 4.7), applying other strategies in measuring the treatment variable by using the ITT approach or operational definition approach (Appendix 4.8), and analysis using dementia as a criterion for determining severity (Appendix 4.9).

Results of sensitivity analysis consistently show that the risk of fracture or preventable hospitalization experience is higher among IC service users, regardless of their initial health status. Statistically insignificant effect of IC on depression among those with severest and mildest initial health status (grade 1, grade 5) was also consistently observed. Statistically insignificant effect of IC on depression among the moderately disabled samples (grade 3–4) observed in IPTW analysis using a logistic model and CBPS model (Appendix 4.7) may be due to imperfect balance of baseline covariates, as weights derived from both methods have failed to achieve balance (standardized difference <0.05) of baseline cognitive function level (Appendix 3.2).

4.4 Discussion

In general, the results of this section show that IC services worsen health compared to HC services. Although these results resemble the results of previous literature (Blackburn et al., 2016; Chuang et al., 2005; Lee et al., 2014; Lee et al., 2015; Marek et al., 2005; McCann et al., 2009; Miller et al., 2008; Sherwood et al., 1986), it is noteworthy that results of several studies applying experiments or natural experiments were somewhat different (Bakx et al., 2020; Oktay et al., 1987; Werner et al., 2019).

Oktay et al. (1987) used a randomized experiment to compare the effect of community care programs and nursing homes, and showed that participants in community care programs showed better health outcomes after 12 months of follow-up in terms of mortality, ADL and IADL, mental status, perceived health, and life satisfaction, but the difference was statistically insignificant. However, this statistical insignificance may be due to the small sample size (n=112) and loss to follow-up (22%), which is the comparative advantage of my study's observational design.

Werner et al. (2019) used the distance between the beneficiary's home zip code and the closest home health agency and the closest skilled nursing facility (SNF) as an instrument to compare the effect of home care and SNF in post-acute care settings. The study showed that SNF was better in reducing the risk of readmission within 30 days of hospital discharge, but the effect on death within 30 days of hospital discharge or functional status during the care episode was statistically insignificant. This difference in results may be due to the different characteristics of the study population, as the subjects of my study are in long-term

care setting while the subjects of Werner et al. (2019) study were in the post-acute care setting, followed up for much shorter period. It is also noteworthy that the SNF in the US is different from the IC services in Korea, which may be more comparable to the nursing home services in the US.

Bakx et al. (2020) used the leniency of randomly assigned eligibility assessors as an instrument to study the causal impact of nursing home admission eligibility on costs, hospitalization, and mortality. They showed that nursing home admission eligibility had a statistically insignificant effect on mortality. The difference in results with my study may be because Bakx et al. (2020) did not study the effect of nursing home use but the effect of eligibility, and nursing home admission eligibility only increased actual nursing home admission by 18.4%p on tops, while my study focused on nursing home use itself. It may also be due to the characteristics of the study population, as the subjects of my study cover a wide population whose LTC eligibility level varies, while the local average treatment effect (LATE) derived from Bakx et al. (2020) study focused on the more severe population who are at the margins of nursing home admission eligibility. In fact, the results of my study among the severest population (grade 1-2) are comparable to the results of Bakx et al. (2020) study- various sensitivity analyses showed that the effect of IC services on mortality is rather small or statistically insignificant among these severest samples.

One of the findings this study contributes to the literature is that to the author's knowledge, this study is the first study to present that the health deteriorating effect of IC service use diminishes as the baseline health status of service users worsens,

using nationally representable population of newly eligible LTC users of Korea. Study results reveal that health deteriorating effect of institutionalization is smallest among the severest subjects, not only in terms of mortality but also in terms of ADL, IADL, and cognitive functions– and several sensitivity analysis results showed that these effects among the severest subjects could be statistically insignificant. This result has an important implication in designing long–term care service delivery– in terms of health effects, IC service utilization should only be considered among the severest ones. When the result of the final analysis is combined with the baseline characteristics of study subgroups (Table 3.1), it means that only those comparable to the severest groups whose ADL score, IADL score, and Cognition level are on average 0.7, 1.3, and 4.3 should be considered for institutionalization. Considering the scale of the scoring systems applied (ADL score from 0 to 6, IADL score from 0 to 8, cognition level from 0 to 10) and considering the fact that the severest groups (grade 1–2) consist only about 12.9% of the LTC eligible population and 1.6% of the population aged 65 and older in South Korea, current supply and utilization of IC services seem very high[26]. In 2020, the national capacity for IC service was 205,197 beds, which is about 158% of the population with grade 1–2 LTC eligibility, and the number of people who have ever utilized IC service in 2020 was 224,775. Moreover, only 32.1% of IC service users were graded 1 or 2, meaning that the rest are utilized by less severe ones, which in turn implies that these less severe IC users may have experienced more drastic deterioration of health compared to the case when they are

[26] In 2020, the number of people aged 65 and older was 8,151,867, LTC eligible people was 1,007,423, and people with grade 1-2 LTC eligibility was 130,038 (https://kosis.kr/).

deinstitutionalized. Although health may not be the only relevant factor to be considered in the decision of LTC service delivery, when the results of previous studies showing that IC services are more costly than HC services (Chappell et al., 2004; Kok et al., 2015) are applicable in the South Korean context, current utilization status of IC services among the less severe ones may imply failure in allocative efficiency of long-term care.

Another important finding of this study is that the assumed underlying pathway of how the LTC place might impact health is supported by empirical results of this study. In this study, I have argued that institutionalization should not be considered just as a type of LTC service, but it is a migration disconnecting one from their previous social capital and living arrangements. Borrowing the concept of public health framework for healthy ageing from the world report on ageing and health (WHO, 2015), I have suggested that institutionalization can deteriorate health through changes in physical and psychosocial environment and continuity of healthcare services, although the existence of 24 hours nursing staff in IC settings may have some offsetting effects. Results of the empirical analysis support these ideas (Table 4.2). In general, institutionalization increased the possibility of depression, fracture, and preventable hospitalization, while the severest group had shown decrease of inappropriate ER visits. Moreover, these effects were more prominent among the mildest, which may explain the differential effect of LTC place on health. However, results on ER visits should be viewed with caution-first, it may be due to the existence of 24 hours nursing staff in IC settings but may also be the secondary result of health effects of IC use; second, although the fact that inappropriate ER visits were less frequent among the

severest IC user may imply the difference in caregiving availability, it may not mean that the general quality of care is better in IC environments. Overall, results in table 4.2 suggest that the general aspects of IC– such as alienation with one's social capital built in their community are likely to deteriorate health, although the extent of this effect may differ by the beneficiary's initial health status.

There are several limitations of the study. First, the scope of this study was limited to comparing the effect of IC services (which may be comparable to nursing homes in other countries) and HC services, while there exist another stratum of service supplying long-term care in Korea-the long-term care hospitals (LTCH) which is compensated by NHI (Kim et al., 2015). Since key variables such as ADL, IADL, or cognitive capacity were not available among pure LTCH users and as LTCH users may differ in initial health status as they include post-acute care users, this study focused on comparing the effect of LTCI-covered IC services and HC services. Therefore, the study samples of this study consisted of people who intended and actually utilized LTC services from the baseline. However, as those who ever entered LTCH during the follow-up period were sizable in the study sample (15%), a sensitivity analysis excluding those who ever entered LTCH during the follow-up period was additionally performed and showed similar results of the main analysis (Appendix 4.10). Main results were reported using the whole sample including LTCH users for the following reasons. One is that as entering LTCH during the follow-up period may be affected by both LTC place and health status, simply removing them may result in selection bias. Moreover, utilization of LTCH during the follow-up period could be considered as an effect of LTC place, meaning that utilization of

LTCH could also be regarded as utilization of health care services which was treated as one of the effect pathways of LTC place on health.

Second, there may still remain biases due to unmeasured confounding covariates and treatment of switch users. Although I have used various covariates from rich NHIS data in order to account for factors that may confound the results (Table 3.2), it cannot be guaranteed that baseline covariates controlled in this study are sufficient to control all the theoretic confounding factors, and it cannot also be guaranteed that the list of factors suggested by Travers et al. (2020) sufficiently captures all the factors explaining the decision regarding LTC utilization. However, if we consider that the size of bias due to unmeasured confounding covariates may depend on both the size of the relation between that covariate and the treatment and dependent variables, I would like to argue that the bias due to unmeasured confounding would be small after controlling a such comprehensive set of covariates. Bias due to sample selection could be problematic, as it is available for LTC beneficiaries to change their settings of services in Korea. However, the proportion of switch users who have changed their service during the 1-year follow-up period was not large (6.1%) and various sensitivity analyses showed robust results. Further studies borrowing random treatment assignments from experiments or natural experiments may complement these limitations. Furthermore, it should be noted that there might be systematic differences by LTC place in measuring ADL, IADL, and cognition status during reassessments after 1 year period. As providers are more highly compensated for caring for those with higher grades, IC providers may have incentives to up-code their resident's status,

although it may not be easy as this reassessment process is done by the third-party employees of NHIS.

It will be also important to notice that health outcomes are not the only factors to be considered. Considering that other factors consisting overall quality of life such as social interactions are also likely to be diminished by institutionalization (Robison et al., 2011), it seems fair to conclude that in general, quality of life is negatively affected by institutionalization. However, other factors such as the cost of formal and informal caregiving should be also considered, in order to investigate whether the deinstitutionalization of long-term care should be more seriously pursued. It is often argued that the costs of IC services are higher compared to HC services (Blackburn et al., 2016; Chappel et al., 2004; Marek et al., 2012), but it may not be true when IC service can substitute utilization of more expensive hospitalization by fulfilling the care needs which may not be met in HC settings (Bakx et al., 2020; Werner et al., 2019). Therefore, the impact of LTC place on formal LTC costs and other medical care utilization in the context of Korean settings will be explored in the next chapter. Moreover, it should also be considered that the relationship between informal caregiving and formal care may be different in accordance with the type of formal care (Bremer et al., 2017; Norton, 2016), and some studies suggested that the costs of HC services may not be cheaper when the cost of informal caregiving is considered (Chiu et al., 2001; Stommel et al. 1993). Although the impact of LTC place on informal caregiving was not directly explored in this study due to the limitation of data, further discussion will be delivered in the next chapter along with the study results comparing the impact of LTC place on formal LTC costs and medical care utilization.

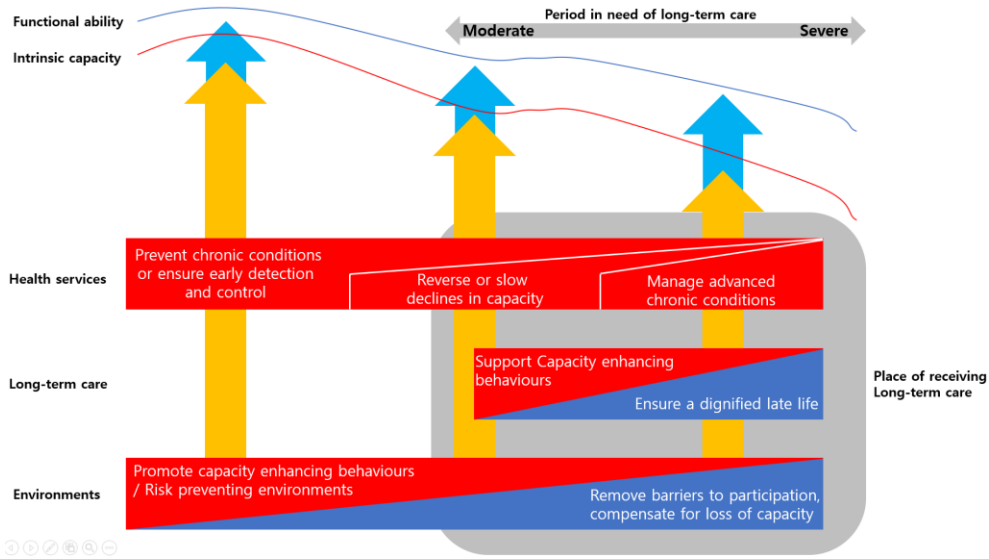


Figure 4.1. Conceptual model on the relations of LTC place and healthy ageing[27]

[27] Figure 4.1 was illustrated by author referring to the figure of WHO's public health framework for healthy ageing (2015)

[Table 4.1] Effect of LTC place on health (covariate adjusting EB weights adjusted)

		Without adjustment				Adjustment of covariates using EB weighting			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 1	Death	0.099(0.003)**	0.011(0.008)	0.075(0.003)**	0.06(0.008)**	0.057(0.004)**	0.028(0.01)**	0.058(0.005)**	0.058(0.009)**
	ADL	-0.892(0.01)**	-0.002(0.018)	-0.677(0.012)**	-0.914(0.033)**	-0.55(0.016)**	-0.054(0.022)*	-0.524(0.018)**	-0.928(0.041)**
	IADL	-0.985(0.011)**	-0.106(0.018)**	-0.809(0.013)**	-1.043(0.04)**	-0.581(0.018)**	-0.075(0.024)**	-0.551(0.021)**	-0.978(0.049)**
	Cognition	-1.554(0.018)**	-0.468(0.046)**	-1.479(0.021)**	-1.052(0.046)**	-0.806(0.029)**	-0.191(0.066)**	-0.838(0.037)**	-0.923(0.059)**
Treatment 2	Death	0.098(0.003)**	0.02(0.008)*	0.073(0.003)**	0.057(0.008)**	0.056(0.004)**	0.035(0.01)**	0.057(0.005)**	0.056(0.009)**
	ADL	-0.848(0.01)**	-0.014(0.017)	-0.635(0.012)**	-0.85(0.033)**	-0.512(0.015)**	-0.06(0.022)**	-0.486(0.018)**	-0.863(0.04)**
	IADL	-0.939(0.011)**	-0.116(0.018)**	-0.764(0.013)**	-0.976(0.04)**	-0.545(0.018)**	-0.085(0.023)**	-0.516(0.02)**	-0.915(0.048)**
	Cognition	-1.484(0.018)**	-0.481(0.045)**	-1.403(0.021)**	-0.988(0.046)**	-0.766(0.028)**	-0.222(0.063)**	-0.795(0.035)**	-0.868(0.058)**
Treatment 3	Death	0.068(0.002)**	-0.016(0.007)*	0.056(0.003)**	0.048(0.005)**	0.038(0.003)**	-0.008(0.008)	0.043(0.003)**	0.045(0.005)**
	ADL	-0.791(0.008)**	0.033(0.016)*	-0.662(0.009)**	-0.919(0.02)**	-0.575(0.01)**	-0.027(0.018)	-0.569(0.012)**	-0.919(0.022)**
	IADL	-0.859(0.009)**	-0.052(0.017)**	-0.755(0.01)**	-1(0.026)**	-0.566(0.012)**	-0.025(0.02)	-0.548(0.014)**	-0.945(0.028)**
	Cognition	-1.332(0.014)**	-0.313(0.042)**	-1.334(0.016)**	-0.972(0.03)**	-0.702(0.019)**	-0.011(0.053)	-0.747(0.023)**	-0.839(0.033)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as IC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* EB: Entropy balancing; ADL: activities of daily living; IADL: instrumental activities of daily living

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Table 4.2] Effect of LTC place on pathways affecting healthy ageing (covariate adjusting EB weights adjusted)

		Without adjustment				Adjustment of covariates using EB weighting			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 1	Depression	-0.006(0.001)**	-0.004(0.002)+	-0.004(0.001)**	0.001(0.005)	0.006(0.002)**	0.007(0.005)	0.006(0.003)*	0.005(0.006)
	Fracture	0(0.002)	0.005(0.004)	-0.001(0.002)	0.03(0.007)**	0.017(0.003)**	0.011(0.005)*	0.014(0.004)**	0.039(0.01)**
	PH	0.046(0.003)**	0.045(0.006)**	0.044(0.003)**	0.069(0.009)**	0.062(0.004)**	0.062(0.008)**	0.054(0.005)**	0.095(0.013)**
	ER1	0.013(0.002)**	-0.031(0.005)**	0.008(0.002)**	0.021(0.005)**	0.014(0.003)**	-0.016(0.007)*	0.016(0.004)**	0.027(0.007)**
	ER2	0.025(0.003)**	-0.017(0.007)*	0.016(0.004)**	0.059(0.01)**	0.037(0.005)**	0.021(0.01)*	0.033(0.006)**	0.066(0.013)**
Treatment 2	Depression	-0.006(0.001)**	-0.005(0.002)*	-0.005(0.001)**	0.001(0.005)	0.006(0.002)**	0.005(0.005)	0.006(0.003)*	0.005(0.006)
	Fracture	-0.002(0.002)	0.004(0.004)	-0.004(0.002)**	0.028(0.007)**	0.014(0.003)**	0.01(0.005)+	0.011(0.004)**	0.036(0.009)**
	PH	0.04(0.003)**	0.039(0.006)**	0.037(0.003)**	0.063(0.009)**	0.054(0.004)**	0.053(0.008)**	0.047(0.005)**	0.088(0.013)**
	ER1	0.011(0.001)**	-0.03(0.005)**	0.009(0.002)**	0.014(0.003)**	0.012(0.002)**	-0.015(0.006)**	0.015(0.002)**	0.018(0.004)**
	ER2	0.060(0.002)**	-0.001(0.007)	0.057(0.003)**	0.088(0.007)**	0.078(0.003)**	0.032(0.008)**	0.082(0.004)**	0.089(0.007)**
Treatment 3	Depression	-0.002(0.001)+	0(0.002)	-0.001(0.001)	0(0.003)	0.009(0.002)**	0.008(0.003)*	0.01(0.002)**	0.005(0.003)
	Fracture	0.015(0.001)**	0.008(0.003)*	0.016(0.002)**	0.032(0.004)**	0.028(0.002)**	0.009(0.004)*	0.029(0.003)**	0.035(0.005)**
	PH	0.069(0.002)**	0.053(0.006)**	0.07(0.003)**	0.083(0.006)**	0.083(0.003)**	0.065(0.007)**	0.081(0.004)**	0.092(0.007)**
	ER1	0.013(0.002)**	-0.028(0.005)**	0.007(0.002)**	0.021(0.005)**	0.013(0.003)**	-0.015(0.006)*	0.015(0.004)**	0.026(0.007)**
	ER2	0.018(0.003)**	-0.021(0.007)**	0.008(0.004)*	0.051(0.01)**	0.029(0.005)**	0.014(0.009)	0.025(0.005)**	0.058(0.013)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* EB: Entropy balancing; PH: preventable hospitalization; ER1: visited emergency room, died, or sent back; ER2: visited emergency room, got hospital treatment

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

References

Almedom, A. M. (2005). Social capital and mental health: An interdisciplinary review of primary evidence. Social Science & Medicine, 61(5), 943-964.

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. Journal of Health Economics, 73, Article 102354. https://doi.org/10.1016/j.jhealeco.2020.102354

Beard, J. R., Officer, A., De Carvalho, I. A., Sadana, R., Pot, A. M., Michel, J.-P., Lloyd-Sherlock, P., Epping-Jordan, J. E., Peeters, G. G., & Mahanani, W. R. (2016). The World report on ageing and health: a policy framework for healthy ageing. The lancet, 387(10033), 2145-2154.

Blackburn, J., Locher, J. L., & Kilgore, M. L. (2016). Comparison of long-term care in nursing homes versus home health: costs and outcomes in Alabama. The Gerontologist, 56(2), 215-221.

Bremer, P., Challis, D., Hallberg, I. R., Leino-Kilpi, H., Saks, K., Vellas, B., Zwakhalen, S. M., Sauerland, D., & Consortium, R. (2017). Informal and formal care: Substitutes or complements in care for people with dementia? Empirical evidence for 8 European countries. Health Policy, 121(6), 613-622.

Chappell, N. L., Dlitt, B. H., Hollander, M. J., Miller, J. A., & McWilliam, C. (2004). Comparative costs of home care and residential care. The Gerontologist, 44(3), 389-400.

Chiu, L., Shyu, W. C., & Liu, Y. H. (2001). Comparisons of the cost-effectiveness among hospital chronic care, nursing home placement, home nursing care and family care for severe stroke patients. Journal of Advanced Nursing, 33(3), 380-386.

Chuang, K.-Y., Wu, S.-C., Yeh, M. C., Chen, Y.-H., & Wu, C.-L. (2005). Exploring the associations between long-term care and mortality rates among stroke patients. The journal of nursing research: JNR, 13(1), 66-74.

Coast, J., Smith, R. D., & Lorgelly, P. (2008). Welfarism, extra-welfarism and capability: the spread of ideas in health economics. Social Science & Medicine, 67(7), 1190-1198.

Colombo, F., Llena-Nozal, A., Mercier, J., & Tjadens, F. (2011). Help Wanted? https://doi.org/doi:https://doi.org/10.1787/9789264097759-en

Couzner, L., Ratcliffe, J., & Crotty, M. (2012). The relationship between quality of life, health and care transition: an empirical comparison in an older post-acute population. Health and Quality of Life Outcomes, 10(1), 1-9.

DePalma, G., Xu, H., Covinsky, K. E., Craig, B. A., Stallard, E., Thomas III, J., & Sands, L. P. (2013). Hospital readmission among older adults who return home with unmet need for ADL disability. The Gerontologist, 53(3), 454-461.

Ettner, S. L. (1999). The relationship between continuity of care and the health behaviors of patients: does having a usual physician make a difference? Medical care, 547-555.

Gaugler, J. E., Kane, R. L., Kane, R. A., & Newcomer, R. (2005). Unmet care needs and key outcomes in dementia. Journal of the American Geriatrics Society, 53(12), 2098-2105.

Guo, J., Konetzka, R. T., & Manning, W. G. (2015). The causal effects of home care use on institutional long-term care utilization and expenditures. Health economics, 24, 4-17.

Jeong, K.-J., Kim, J., Kang, H.-Y., & Shin, E. (2016). Hospital admission rates for ambulatory care sensitive conditions in south korea: could it be used as an indicator for measuring efficiency of healthcare utilization? Health Policy and Management, 26(1), 4-11.

Kim, H., Jung, Y.-I., & Kwon, S. (2015). Delivery of institutional long-term care under two social insurances: Lessons from the Korean experience. Health Policy, 119(10), 1330-1337.

Kim, J., Choi, Y., & Park, E. C. (2019). Incidence of hip fracture among long-term care insurance beneficiaries with dementia: comparison of home care and institutional care services [Article]. Bmc Geriatrics, 19, 9, Article 152. https://doi.org/10.1186/s12877-019-1161-8

Kok, L., Berden, C., & Sadiraj, K. (2015). Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores. The European Journal of Health Economics, 16(2), 119-131. https://doi.org/10.1007/s10198-013-0557-1

Konetzka, R. T. (2014). The Hidden Costs of Rebalancing Long-Term Care. Health Services Research, 49(3), 771-777. https://doi.org/https://doi.org/10.1111/1475-6773.12190

Lee, T. W., Cho, E., Yim, E. S., Lee, H. S., Ko, Y. K., Kim, B. N., & Kim, S. (2015). Activities of Daily Living in Nursing Home and Home Care Settings: A Retrospective 1-Year Cohort Study. Journal of the American

Medical Directors Association, 16(2), 114-119. https://doi.org/https://doi.org/10.1016/j.jamda.2014.07.013

Lee, T. W., Yim, E., Cho, E., & Chung, J. (2014). Cognitive function, behavioral problems, and physical function in long-term care insurance beneficiaries with dementia in South Korea: comparison of home care and institutional care services. Journal of the American Geriatrics Society, 62(8), 1467-1475.

Marek, K. D., Stetzer, F., Adams, S. J., Popejoy, L. L., & Rantz, M. (2012). Aging in place versus nursing home care: Comparison of costs to Medicare and Medicaid. Research in gerontological nursing, 5(2), 123-129.

McCann, M., O'Reilly, D., & Cardwell, C. (2009). A Census-based longitudinal study of variations in survival amongst residents of nursing and residential homes in Northern Ireland. Age and Ageing, 38(6), 711-717.

McKenzie, K., Whitley, R., & Weich, S. (2002). Social capital and mental health. The British Journal of Psychiatry, 181(4), 280-283.

Miller, J., Shi, X., & Cohen, M. (2008). Private long-term care insurance: Following an admission cohort over 28 months to track claim experience, service use, and transitions. Washington, DC: Assistant Secretary for Planning and Evaluation, US Department of Health and Human Services. Retrieved December, 4, 2009.

NHIS. (2022). 2021 Long term care insurance statistical yearbook. National Health Insurance Service: Wonju.

Norton, E. C. (2016). Chapter 16 - Health and Long-Term Care. In J. Piggott & A. Woodland (Eds.), Handbook of the Economics of Population Aging (Vol. 1, pp. 951-989). North-Holland. https://doi.org/https://doi.org/10.1016/bs.hespa.2016.06.001

Oktay, J. S., & Volland, P. J. (1987). Foster home care for the frail elderly as an alternative to nursing home care: an experimental evaluation. American Journal of Public Health, 77(12), 1505-1510.

Radden, J. (2012). Privacy and patient autonomy in mental healthcare. Autonomy and mental disorder, 123-142.

Robison, J., Shugrue, N., Reed, I., Thompson, N., Smith, P., & Gruman, C. (2011). Community-based versus institutional supportive housing: Perceived quality of care, quality of life, emotional well-being, and social interaction. Journal of Applied Gerontology, 30(3), 275-303.

Sherwood, S., Morris, J. N., & Ruchlin, H. S. (1986). Alternative paths to long-term care: nursing home, geriatric day hospital, senior center, and

domiciliary care options. American Journal of Public Health, 76(1), 38-44.

Starfield, B. (1994). Is primary care essential? The lancet, 344(8930), 1129-1133.

Stommel, M., Given, C. W., & Given, B. A. (1993). The cost of cancer home care to families. Cancer, 71(5), 1867-1874.

Travers, J. L., Hirschman, K. B., & Naylor, M. D. (2020). Adapting Andersen's expanded behavioral model of health services use to include older adults receiving long-term services and supports. BMC geriatrics, 20(1), 1-16.

Weiss, L. J., & Blustein, J. (1996). Faithful patients: the effect of long-term physician-patient relationships on the costs and use of health care by older Americans. American Journal of Public Health, 86(12), 1742-1747.

Werner, R. M., Coe, N. B., Qi, M., & Konetzka, R. T. (2019). Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA internal medicine, 179(5), 617-623.

WHO. (2015). World report on ageing and health. World Health Organization.

Wysocki, A., Butler, M., Kane, R. L., Kane, R. A., Shippee, T., & Sainfort, F. (2015). Long-term services and supports for older adults: A review of home and community-based services versus institutional care. Journal of Aging & Social Policy, 27(3), 255-279.

Young, C., Hall, A. M., Gonçalves-Bradley, D. C., Quinn, T. J., Hooft, L., van Munster, B. C., & Stott, D. J. (2017). Home or foster home care versus institutional long-term care for functionally dependent older people. Cochrane Database of Systematic Reviews(4).

Chapter 5. Institutional care versus home care: How different are the patterns of health care utilization?

5.1 Conceptual framework

Results of the previous chapter have revealed that in general, institutional care (IC) services worsen health compared to home and community based care (HC) services. It was also prominent that long-term care (LTC) place can affect health through differences in healthcare utilization and environmental factors, even after adjusting various baseline differences between IC and HC users. These results were delivered using a cautious approach, as 'LTC place' is not a static concept. For example, even though a person has begun utilizing HC service, he or she can move to IC service during the follow-up period. Since this change in treatment status could be affected by the effect of the former treatment, simply treating these 'switch users' could cause bias. In the previous chapter, the dynamic property of 'LTC place' was dealt with by incorporating various sensitivity analyses assigning switch users by applying several different definitions. This approach was available as the outcome of the interest was health status at the end of the 1-year follow-up. The same approach could be applied when the outcome of interest is total formal health and long-term care costs during the follow-up period. In this chapter, I will first estimate the difference in costs due to utilizing formal health and

long-term care during the follow-up between IC and HC users, especially focusing on whether this difference in costs differs by the initial health status of the service user. This analysis along with the results from the previous chapter could inform the decision regarding who can benefit the most from LTC deinstitutionalization, although it will require more information on other factors such as informal caregiving burden in order to consider the total costs from the societal perspective (König et al., 2014). However, such an approach simply estimating the impact of yearlong LTC place on formal health and long-term care costs can only identify the total effect of LTC place and fails to separate two different effects of LTC place on health care utilization – a direct effect and an indirect effect through changes in health status[28]. As shown in the previous section, LTC place can affect health. Therefore, the difference in healthcare costs will occur due to differences in health status change. This type of indirect effect of LTC place on healthcare utilization is of less interest, as it merely demonstrates health differences which were already portrayed in the previous chapter.

The direct effect of LTC place on health care utilization pattern is much more interesting, as it could be one of the underlying pathways of how LTC place can affect both health and costs. As shown from the results of the previous chapter, LTC institutionalization seemed to worsen the prevention or management of chronic diseases, as IC users experienced more preventable hospitalizations compared to HC users. This implies that a negative direct effect of IC service on essential primary care service

[28] Separation of direct effect and indirect effect through mediators are widely considered in epidemiological studies. In this study, 'health status change' was considered as a factor mediating the effect of LTC place on health care utilization.

utilization may exist. As previous literature suggests, high proportions of hospitalization events experienced by nursing home users are preventable (Carter, 2003; Ouslander et al., 2010). On the other hand, it should be considered that institutional care users may benefit in care for advanced conditions or end-of-life care as they can receive care from 24 hours rotating nursing staff. The existence of 24 hours rotating nursing staffs in IC settings may mediate the direct effect of LTC institutionalization on substituting more costly hospitalizations, as several studies have suggested (Sands et al., 2008; Schwarzkopf et al., 2013; Shireman et al., 2004). These results from previous chapter and the literature both show the tendency of the negative direct effect of IC service on medical care utilization, although their impact on the health system widely differs. The former effect of IC service on primary care service utilization could imply an unmet need in care and the latter effect on hospitalization could imply efficient substitution. Moreover, the underlying mechanism beneath this "direct effect" may also be complicated.

If we can consider the providers of IC services as a profit-maximizing entity, they will have high incentives to keep their residents as long as possible if they are reimbursed by a per-diem-based compensation system, like it is in Korea (Colombo et al., 2011; Gori et al., 2015). Combined with the fact that IC services are usually mandated to employ 24 hours rotating nursing staff (de Bienassis et al., 2020), this may partly explain the negative incentive of IC service providers on hospitalization, which is also in line with study results showing more intensive use of medication in IC settings regarding behavioral and psychosocial symptoms of dementia or pain (Gruber-Baldini et al., 2007; Mitchell et al., 2004;

Rigler et al., 2004).

Providers of IC services may have conflicting interests regarding the resident's utilization of primary care services. On the one hand, adequate utilization of primary care services may be beneficial to the provider's profit, by reducing the chance of health shocks and prolonging the length of stay in their services. On the other hand, utilization of primary care could increase the short-term risk of referral to higher level medical institutions by discovering unmet medical needs, while the benefit due to better health care could only be realized later. Consideration for the latter aspect could be maximized when there are long waiting lines for IC services and regulations on the quality of services are insufficient, considering the fact that service users may be less sensitive to medical care quality due to information asymmetry especially when they are cognitively impaired (Haas-Wilson, 2001). The cost of transportation may reinforce these effects. In settings where the cost of transportation is not separately compensated for those who reside in IC services, HC users and their informal caregivers will face less cost for visiting medical institutions compared to IC users. This may be still true even when the cost of transportation is not separately compensated in both IC and HC settings, since informal caregivers may have to face the cost of having to travel longer distances- adding the round-trip distance from home to the facility. Moreover, disconnection from the usual source of health care providers could negatively affect access to primary care services especially when the quality of IC services is poor (Carter, 2003) and adequate care transition process is not available (Groenvynck et a., 2022).

Studies on this type of direct effect of LTC place on health care

utilization could provide some valuable insights on redesigning health care system for the aged society, although it is difficult to disentangle the direct and indirect effect of LTC place on medical utilization as it requires to navigate the dynamic relation between LTC place, health, and medical utilization (Figure 5.1). Considering the complex relation between LTC place, medical utilization, and health, it is difficult to explore the full relationship between them especially because measurement of health status in-between the follow-up period is difficult. Although it is possible to create measures such as Charlson's Commorbidity Index (CCI) scores using claim data of healthcare utilization in-between the follow-up period, it may be insufficient to capture various aspects of health among frail older adults, and more importantly, it should be noted that healthcare utilization which is used to create CCI score itself could be affected by the direct effect of LTC place. Therefore, health, which is the mediator of interest in separating indirect and direct effects in this study, can only be measured at two time points in our data: when a participant first enters long-term care and one year later. As health measured at the baseline should be considered as a confounding covariate, the mediator (health) could be only measured once in the study data. Given the limitation of study data, simpler static model could be assumed (Appendix 5.1, A) in order to incorporate recently developed causal mediation analysis which quantitatively decomposes the direct and indirect effect (Rijnhart et al., 2021). Health status measured 1 year later could be treated as a mediator and medical care utilization during the first 1-2 years after entering long-term care could be used as the dependent variable. Given some of the limitations inherent in this approach[29], I

[29] One strongest assumption required for causal mediation analysis is a so-

present the results of the above analyses as supplemental findings for reference only, although these results also supported the results of my main analysis. Instead, healthcare costs and utilization during the 1-year follow-up period (total effect) were analyzed using various sub-division of healthcare utilization, in order to explore the healthcare utilization patterns in accordance with LTC place, bringing some insights about the direct effect of LTC place on medical utilization.

In this study, the total effect of LTC place on total formal healthcare costs including both LTCI services and NHI services during the follow-up period was first estimated, and subdivided as

---

called 'cross-world independence assumption,' which is often interpreted as no confounders of the mediator-outcome relationship are affected by the exposure (Pearl, 2012; Steen et al., 2017; VanderWeele & Vansteelandt, 2009). It is hard to argue that this assumption could be satisfied in this study, especially because the concept of 'health' could not be fully captured from the study data. For example, it is hard to argue that other unmeasured confounders of 'health-medical utilization' relationship such as disease onset or worsening, and attitude towards medical care are not affected by the exposure (LTC place), which makes it difficult to meet the identification condition of causal mediation analysis. One approach of handling this problem is considering these related factors jointly as a mediator (VanderWeele & Vansteelandt, 2013). In this study, a joint mediator approach incorporating four different health variables (ADL, IADL, cognition level, death) were applied to loosen this assumption, although it is still difficult to consider all important health related factors as they are hard to be measured.

Another problem with this analysis is that changes in health and changes in healthcare utilization are constantly interacting with each other, making it difficult to completely separate the timing of measuring the mediator and the outcome. One of the plausible approach possible in this study is to use health care utilization between one year after initial entry and two years prior as the outcome. An important problem arising from this approach is the question regarding whether 'death' is appropriate as a mediator. Given that death is one of the main health conditions that can be affected by LTC place, the treatment variable in this study, it is natural that death should be considered as a key mediator, but the fact that decedents have zero subsequent healthcare utilization can pose a problem for the estimation of causal mediation analysis.

follows: LTCI service costs and NHI service costs, and NHI service costs were further divided into inpatient service utilization and outpatient service utilization. The result of the analysis suggested that the total effects of LTC institutionalization on outpatient and inpatient NHI service utilization could be negative[30] (Table 5.1-2), which implies the existence of a negative direct effect of LTC institutionalization on NHI service utilization as the indirect effect of LTC institutionalization on NHI service utilization through health status change may be positive[31]. Moreover, results of supplemental causal mediation analysis supports these conclusions (Appendix 5.1, B). An important question that arises from this result is, where does this negative direct effect of LTC institutionalization on medical costs come from, and whether it is good or bad. In other words, what does the reduction of medical costs among IC users mean? Unmet medical needs or gain in efficiency?

The result that there exists a negative direct effect of LTC institutionalization on outpatient services regardless of their initial health status gets well along with the result from the previous chapter, that LTC institutionalization increases the probability of experiencing hospitalization due to preventable and manageable conditions in outpatient settings. It seems reasonable to believe that IC users experience more unmet medical needs in outpatient settings compared to HC users, although it cannot be guaranteed that these are purely unmet needs since some proportion of the

[30] Total effect of LTC institutionalization on outpatient NHI service costs and outpatient visits was negative regardless of initial health status, and the total effect on inpatient NHI service costs and inpatient days in acute hospital was negative among the severest (grade 1-2) samples.

[31] Since LTC institutionalization had negative effect on health outcomes in the previous chapter, indirect effect of LTC institutionalization on medical utilization through health may have positive value.

decreased medical service utilization may have improved efficiency by reducing the use of less effective services. Moreover, it will be too early to conclude that the negative direct effect of LTC institutionalization on medical care utilization is generally related to unmet needs, as the negative direct effect of LTC institutionalization on inpatient services is more subtle. As providers of IC services could have high incentives to keep their residents as long as possible, it may be reasonable to assume that the negative direct effect of LTC institutionalization on inpatient services could also be related to unmet needs in medical care. However, this tendency may have beneficial results in terms of efficiency, especially among the severest population by delaying the utilization of less effective but costly hospitalization services. The result that the negative direct effect of LTC institutionalization on inpatient services exists among the severest group (grade 1-2) is telling, as this group has shown the smallest health status difference due to LTC place (see previous chapter), which in turn implies smallest amount of the unmet medical needs.

Two additional approaches were used in order to further explore the characteristics of the negative direct effect of LTC institutionalization on medical utilization. First, the effect of LTC place on inpatient NHI service utilization was further explored by applying a 2-part model, using two types of services as follows: long-term care hospital admission, and acute care hospital admission during the last 90 days of life[32]. Long-term care hospital admission was intended to capture the difference in advanced

[32] Admission in general hospital and tertiary general hospital were classified as acute care hospital admission. Sub-sample who expired between follow-up period (90 days after entering LTC services) were used, and EB weights were re-calculated using this sub-sample.

condition care, and acute care hospital admission during the last 90 days of life was intended to capture the difference in end-of-life care, which are selected as the two representative conditions that may benefit from 24 hours rotating nursing staffs available in LTC institutions and also considered as proxy conditions of less efficient-supply sensitive care, following the notion of Wennberg et al. (2002) and Chandra and Skinner (2012). A negative direct effect in these two types of services may imply the substitution of more costly and less efficient inpatient services. Second, four categories of NHI service costs, which are outpatient service, long-term care hospital admission, acute care hospital admission, and other inpatient services, were further subdivided into primary causes of care using the main diagnosis and the International Classification of Diseases 10th revision (ICD-10) chapters[33]. This analysis was intended to gather more descriptive understanding of which are the major disease categories where the difference in medical care utilization due to LTC place had mainly occurred. The negative total effect of LTC place on each of the subdivided medical costs may imply a negative direct effect of LTC place, suggesting some descriptive picture for a qualitative explanation.

[33] This study utilized NHIS data which codes disease categories adopting KCD which is based on ICD-10. See more about ICD-10 at https://icd.who.int/browse10/2019/en#/

5.2 Measurements

As Korea has mandatory and universal health and long-term care system based on social insurance (Kim & Kwon, 2021), and as the national level insurer, NHIS, is in charge of both NHI and LTCI schemes, payments made by NHIS reflects the total cost and service utilization in the public care sector. In general, services covered by LTCI and NHI could be roughly understood as social and medical care services respectively, although some grey areas exist. For example, visiting nurse services compensated by LTCI or LTCH services compensated by NHI would be the two cases representing ambiguousness. However, as visiting nurse services compensated by LTCI has a negligible proportion among total LTCI service utilization (Hwang & Park, 2019) and also relatively very small compared to the other professional visiting nurse service which is compensated by NHI in Korea (Lee et al., 2021), it will be fair to interpret each service covered by LTCI and NHI as social and medical care services respectively when LTCH services are separately treated. Although there exists another public sector tax-based social care service called 'Customized Care Services for Older Adults', considering the fact that the size of the budget is relatively small and that those who benefit from LTCI are not the subject of 'Customized Care Services for Older Adults' which targets those who are of mild severity and financial difficulty (Chon, 2020), it would be fair to exclude the costs and utilization of these services when the study population of interest is LTCI eligible frail old aged people.

Two other important sources of social impacts related to LTC place should be considered. First, formal services uncovered by

NHI or LTCI should be considered. This is especially important when considering medical care services, as NHI coverage for medical care services is less than 65% during the study period (NHIS, 2020). Even after accounting for coinsurance payments for covered services, there still remains up to 17.2% of costs for uncovered medical services which are not captured in the NHIS data (NHIS, 2020). In this study, the total annual cost of NHI covered medical services accounting payments made by both the insurer and the beneficiary during the follow-up period was used to capture the medical side of formal care utilization. Although this approach has limitations in capturing the total costs related to medical service utilization, it is still available to show the relative amount and characteristics of service use, considering the fact that mixed treatment of NHI covered and uncovered services are allowed in Korea (Kwon, 2003). This is less important when considering social care services covered by LTCI, as the costs due to uncovered services are almost negligible in this sector, except for the out-of-pocket payments for meal ingredients (Kwon et al., 2012). When comparing the social costs related to LTC service by the place of receiving LTC, it should be noted that LTCI covers the costs for rooms and boards (except for the out-of-pocket payments for meal ingredients) of IC services in Korea. However, due to the fact that the Korean LTCI scheme compensates these costs using a nationally fixed price schedule, suppliers may have fewer incentives in investing in physical quality, which may be one of the reasons why the costs related to hotel services account for only 3.6~4.8% of total costs of formal IC services in Korea (Kwon et al., 2021). Secondly, it should be noted that the burden of informal caregiving could be differently affected by LTC place

(Bremer et al., 2017; Norton, 2016). However, although it is obvious that informal caregiving is critical in terms of the factor consisting social impact of LTC place, this study has focused on the impact of LTC place on the formal care sector, due to the limitation of the data. Instead, the average cost of informal caregiving among Korean HC service users will be considered in the discussion, using the results found from the literature (Ham & Hong, 2017).

In the Korean context where the annually set national price is applied to both formal long-term care insurance (LTCI) and national health insurance (NHI) funded formal medical services, formal care costs (calculated using a nationally set price schedule) may not reflect the true opportunity cost for delivering the services. However, it may act as a proxy value at the national level, considering the fact that the national price schedule and level reflect the results of costing studies which are used as a tool to back up annual price negotiation between the insurer and providers (Kwon et al., 2019). In order to adjust annual inflation rates, all costs were adjusted to the price level of 2016, using an annually negotiated price increase rate. For NHI funded medical services, the number of outpatient visits and inpatient days of hospital admissions were further studied.

Results of this chapter are derived from the following regression applying weighted least square incorporating covariate balancing weights derived from chapter 2, and robust standard error has been reported.

$$E[Y^T] = \beta_0 + \beta_1 T$$

(Where $E[Y^T]$ is an expectation of outcome variable Y under treatment level T, and treatment T=1 when the subject is defined as IC user)

5.3 Results

Total effect of LTC place on formal care costs

Results of weighted regression adjusting baseline covariates show that in general, LTC institutionalization costs more in terms of formal care costs. This result was consistent regardless of initial health status, although the intent of formal care cost differences was smaller for those with worse initial health status – average annual formal care costs were 4,439,131 WON, 5,484,595 WON, and 5,148,176 WON higher for IC users, respectively among grade 1-2, grade 3-4, grade 5 samples (Table 5.1). The story gets more interesting when the total formal care costs are split into LTCI costs and NHI costs, which could be roughly understood as social care and medical care costs, respectively. In all subgroups based on initial health status and LTC place, the proportion of NHI costs among total formal care costs was substantial, ranging from 35.9% (grade 3-4, IC user) to 61.2% (grade 1-2, HC user), clearly displaying the dual needs of medical and social care among the long-term care eligible (Table 5.1). As one can expect, average costs for NHI services are generally higher among more severe groups, while average costs for LTCI services are highly related to LTC place than baseline severity (Appendix 5.3). In general, average costs for LTCI services were higher among IC users, and the differences increased among those with worse initial health status – average annual LCI costs were 5,962,660 WON, 5,060,736 WON, and 2,624,986 WON higher for IC users, respectively among grade 1-2, grade 3-4, grade 5 samples (Table 5.1). Overall, results suggest that even after adjusting extensive sets of baseline

covariates, IC services had cost more in terms of formal care costs, which could be mainly attributable to the difference in LTCI care costs.

Results were robust to other sensitivity analyses, which applied other strategies in measuring the treatment variable by treating all switch users as IC or HC users (Appendix 5.2), sensitivity analysis using mean formal care costs per survived days in order to adjust for the difference in survival (Appendix 5.4), analysis removing samples who have ever entered LTCH during follow-up (Appendix 5.5), sensitivity analysis involving saturated model (Appendix 5.3), and analysis using dementia as a criterion for determining severity (Appendix 5.6). In general, all sensitivity analysis results showed similar implications with the main analysis, except for the fact that sensitivity analysis removing samples who have ever entered LTCH during follow-up showed that annual NHI costs were lower among grade 3-4 IC users, which may be due to the fact that LTCH costs were higher among grade 3-4 IC users compared to grade 3-4 HC users.

Does LTC institutionalization affect patterns of medical care?

An interesting result related to the effect of LTC place on NHI service costs is shown among the severest group (grade 1-2) – on average, severest IC users used 1,522,389 WON less NHI service compared to severest HC users on average (Table 5.1). As the effect of LTC place on service utilization could be conceptually divided into two parts: indirect effect due to health outcome differences and direct effect on medical service utilization pattern, and as deinstitutionalization is better for health outcomes regardless

of initial health status (see previous chapter), the negative total effect of institutionalization on NHI service utilization can be logically interpreted as the existence of the negative direct effect of institutionalization on NHI service utilization. In this regard, less NHI service costs among the severest IC users implies there certainly exists the negative direct effect of LTC institutionalization on NHI service costs.

Utilization of outpatient services may explain some of this effect. Indeed, the negative direct effect of LTC institutionalization on outpatient service utilization was present among all severity levels (Table 5.1 – 5.2). Among all severity levels, IC users used fewer outpatient services compared to HC users, which amounted 634,272 WON, 723,047 WON, and 333,196 WON less, respectively among grade 1−2, grade 3−4, grade 5 samples (Table 5.1). These results were consistently shown in the analysis measuring NHI service utilization using outpatient visits (Table 5.2). IC users experienced 3.9, 8.0, and 5.9 less outpatient visits compared to HC users, respectively among grade 1−2, grade 3−4, grade 5 samples. The negative direct effect of LTC place on inpatient services costs explains the rest. More specifically speaking, the severest IC users utilized 888,117 WON fewer inpatient services compared to the severest HC users, although this was not the case among the less severe ones (Table 5.1). Severest IC users have also spent 3.2 days less acute hospital admissions compared to HC users, indicating the negative direct effect on inpatient service utilization (Table 5.2).

Can the negative direct effect of LTC institutionalization on inpatient service utilization result in efficiency gain?

As described earlier, the negative total effects of LTC institutionalization of NHI service use can be interpreted as the existence of the negative direct effect of institutionalization on NHI service utilization, although it is hard to tell whether this type of negative direct effect of institutionalization on inpatient service use is also present among the less severe ones. However, a non-ignorable pattern exists – institutionalization had the negative direct effect on outpatient service utilization, and the negative direct effect on inpatient service utilization was also shown at least among the severest ones (Table 5.1-5.2). Moreover, supplemental causal mediation analysis results also supported these ideas by showing that LTC institutionalization may have a negative direct effect on both outpatient and inpatient services regardless of baseline health status (Appendix 5.1, B).

Considering the perverse incentives of IC service providers against medical utilization, it would be convenient to assume that these negative direct effect of institutionalization on NHI service utilization causes unmet need in medical care. As the results in the previous chapter have suggested, LTC institutionalization increases preventable hospitalization, which gets well along with the notion that the negative direct effect of institutionalization on outpatient services could be interpreted as an unmet need in medical care. However, results in Table 5.3 shows that this may not always be the case. Results of weighted regression adjusting baseline covariates show that LTC institutionalization may have a negative direct effect on specific inpatient NHI service utilization, especially

in delaying the entry of long-term care hospitals (LTCH) and reducing the amount of acute hospital utilization during the end-of-life period (Table 5.3). Among those who entered LTCH during follow-up, IC users spent 24,69 days, and 10.86 days less in LTCH compared to HC users, respectively among grade 1-2 and grade 3-4 samples. This result shows that IC service can delay entrance to LTCH compared to HC services. However, the probability of entering LTCH during the 1-year follow-up period almost doubled among IC users compared to HC users. This result may imply that although IC services could delay the entrance to LTCH at the beginning, it eventually fails to meet the need of the beneficiaries due to a more drastic worsening of health status (Table 5.3). Among those who have expired during the follow-up period[34], costs due to acute hospital utilization during the last 90 days of life were much smaller among IC users, spending 1,383,706 WON, and 1,359,944 WON less, respectively among grade 1-2, and grade 3-4 samples, although the difference was statistically insignificant among grade 5 samples. Assuming less effectiveness of hospital admissions in LTCH and end-of-life care, these results show that the negative direct effect of institutionalization on inpatient service utilization could have potential benefit in increasing the efficiency of healthcare system.

Results were robust to other sensitivity analyses, which applied other strategies in measuring the treatment variable by treating all switch users as IC or HC users (Appendix 5.7). These results show that LTC institutionalization does substitutes inpatient medical service use, especially on less effective and supply-sensitive care such as LTCH use or acute hospital use during the end-of-life

[34] Samples who expired before 90 days of follow-up were not used

period.

Where does the negative direct effect of LTC institutionalization on medical care utilization come from?

Analysis of subdivided medical costs using the primary diagnosis of medical service utilization also shows some interesting results providing a descriptive snapshot of which disease categories are the reason where these negative direct effects have occurred. The negative direct effect of LTC place on outpatient service costs was shown in most disease categories, although it was mainly attributable to genitourinary diseases (most importantly chronic kidney disease [N18][35]), neoplasm, and musculoskeletal diseases, which explains the majority of the cost differences among the whole sample (Figure 5.2, panel A). Interestingly, IC users utilized more outpatient services due to mental & behavioral diseases compared to HC users which were most importantly Alzheimer's disease [F00], although it is hard to tell whether this positive total effect is due to the worsening of cognitive functions (as suggested in the previous chapter) or due to more intensive control of behavioral and psychosocial symptoms of dementia in order to stabilize the residents in IC services. In general, the total effects regarding LTCH services were positive which makes it hard to interpret which are the major disease categories where the negative direct effect of LTC institutionalization on delaying the entrance to LTCH service (Table 5.3) has originated (Figure 5.2, panel B). However,

[35] For several conditions of interest, primary cause of medical utilization using ICD-10 third level (two digits followed by the alphabetic code) was quoted, which was acquired by tracing up-to 100 most frequent causes. Available on request.

results of the severest grade 1−2 samples imply the negative direct effect of LTC institutionalization could exist among the severest patients with neoplasms and nervous diseases (most importantly hemiplegia [G81]). Further exploration regarding mental & behavioral diseases (most importantly Alzheimer's disease [F00]) would be necessary, as the positive total effect on LTCH admission due to dementia may imply failure in dementia care in IC settings. Regarding acute hospital services, the severest grade 1−2 IC users used less for most disease categories except for respiratory diseases (most importantly pneumonia [J18]), infectious & parasitic diseases (most importantly tuberculosis [A15]), and skin & subcutaneous diseases (most importantly decubitus ulcer [L89]) (Figure 5.2, panel C). Interestingly, moderately severe grade 3−4 IC users used fewer acute hospital admissions for neoplasm and circulatory diseases, implying the negative direct effect of LTC place on inpatient services among these patients. Regarding hospital admissions in hospitals other than LTCH and acute hospitals, the severest grade 1−2 and grade 3−4 IC users used less for nervous diseases (most importantly hemiplegia [G81]) and neoplasm, although several other disease categories were also less used among grade 3−4 IC users (Figure 5.2, panel D). Results were robust to other sensitivity analyses, which applied other strategies in measuring the treatment variable by treating all switch users as IC or HC users (Appendix 5.8), or analysis which has additionally adjusted baseline medical service expenditures before entering LTCI according to ICD−10 major disease chapters which showed biggest difference[36] (Appendix 5.9). These results show that the

[36] Although measures such as baseline CCI scores were adjusted in the main analysis, primary causes of medical utilization which showed largest

effect of LTC institutionalization on medical costs clearly differs both by the level of services and disease categories.

difference among medical service utilization were selected (Chapter 2, 5, 6, 7, 10, 12, 13, 14), and formal care cost during the last 1 year before entering LTCI was additionally adjusted as a sensitivity analysis.

5.4 Discussion

Results of this chapter demonstrated that in general, LTC institutionalization is more expensive than home and community-based care when the cost of informal caregiving is not accounted for, which is in line with common findings from the literature (Blackburn et al., 2016; Chappell et al., 2004; Corder, 2017; Felix et al., 2011; Hollander & Chappell, 2007; Kitchener et al., 2006; Marek et al., 2012; Shireman & Rigler, 2004; Werner et al., 2019). One of the unique findings this study may add to the literature is that this gap in the cost of formal caregiving seems to decrease as the initial health status of the beneficiary worsens (Table 5.1). Considering the fact that the formal costs for NHI services suggested in this study do not account for costs of medical services not covered by the NHI scheme, and that IC users utilized fewer NHI services compared to HC users among the severest grade 1-2 samples of the study, actual cost differences for total formal care services will be even smaller than suggested among the severest, which fall downs from 4,439,131 WON to 4,122,886 WON when simply applying the fact that average non-covered medical cost accounted for 17.2% of total medical cost in 2016 (NHIS, 2020) is considered. When the same logic is applied to grade 3-4, and grade 5 samples, the difference in cost of formal caregiving between IC users and HC users increases to 5,572,620 WON, and 5,672,236 WON, respectively. Combined with the results from the previous chapter, it could be summarized that LTC institutionalization deteriorates health and is more costly in terms of formal care - and the intent of this difference diminishes as the initial health status worsens.

Due to the lack of data, it was unable to compare the effect of

LTC place on informal caregiving. However, a study using survey data on a nationally representative community residing old aged population has shown that Korean HC users received on average 84.1 hours of informal caregiving per month, in 2014 (Ham & Hong, 2017). Although equivalent information regarding Korean IC users was unavailable, results from a descriptive analysis backgrounding Netherlands which showed that objective informal caregiving burden was on average 83.2 and 39 hours per month (19.2 and 9.0 hours per week in the original article) respectively among HC and IC users (Metzelthin et al., 2017), gives a starting point for a rough comparison. If it can be assumed that HC users generally receive 44 hours more informal caregiving per month, the annual cost of informal caregiving among HC users would be approximately 4,457,904 WON higher compared to IC users, when Korean formal LTC caregiver' s minimum wage rate at the year of 2016 is applied[37]. For grade 3-4 and grade 5 samples, the amount of formal care sector cost increased among the IC users was higher than the informal care cost increments among the HC users, while the converse could be derived among grade 1-2 samples. The combined result suggests that even when the costs for informal caregiving are accounted for, LTC institutionalization could be more expensive compared to HC services among the less severe population, although the opposite could be applied among the severest grade 1-2 population. Considering the results of the previous chapter that health outcomes are better among HC users regardless of their initial health status, the results of this chapter

[37] 44 hours * 12 months * 8,443 WON. Minimum wage rate of formal LTC caregiver was applied, as hourly market wage was comparable to the minimum wage rate (8,443 vs 8,160 in 2016. See Na & Jeong, 2019 for hourly market wage level of LTC caregivers).

suggest that the Korean long-term care system where almost two-thirds of IC users are less severe grade 3-5 population (NHIS, 2022) could gain some allocative efficiency by incorporating more active LTC deinstitutionalization policy targeting less severe IC users.

Results of a few studies incorporating natural experiments should be separately reviewed regarding these results, as these studies have some contradicting points to my study. Bakx et al. (2020) used the leniency of randomly assigned eligibility assessors as an instrument to study the causal impact of nursing home admission eligibility and showed that nursing home admission eligibility has statistically significantly increased nursing home expenditures and reduced home care and medical care expenditure. These results are comparable to the results of grade 1-2 samples of my study, as the Bakx et al. (2020) study focuses on the severe population who are at the margins of nursing home eligibility. However, in my study, LTC institutionalization did not reduce medical expenditures among less severe samples, which could be explained by the offsetting indirect effect due to differences in health status change. Kim & Lim (2015) incorporated regression discontinuity design using 2008-2009 NHIS data and argued that utilization of more IC services among the severest group (equivalent to grade 1 of my study) is related to an increase in medical expenditure, mostly hospital expenses. This result contradicts my study but should be interpreted with caution. Although the authors interpreted the effect of having a higher eligibility score over the grade 1 threshold (grade 1 benefit) as the effect of using more HC services and fewer IC services, it should be noticed that utilization of HC/IC service is just another result of

receiving grade 1 benefit in this study design. As the authors suggest, grade 1 benefit had on average increased by $926 for HC expenditures and 30 days decrease in IC, and at the same time, grade 1 benefit led to a $700 decrease in medical expenditures. Since the results only show the average annual difference in utilization between grade 1 and grade 2 beneficiaries at the margins, it could be the more intensive use of HC services that has caused a reduction in both IC use and medical expenditures, which are comparable to the finding suggesting that high-intensity in HC services decreases nursing home placements (Duan-Porter et al.,2020; Mittelman et al., 2006; Teri et al., 2003). In this sense, the result of Kim & Lim (2015) study does not contradict my findings.

Another interesting finding from this study is that it had shown the existence of the negative direct effect of LTC institutionalization on medical care utilization and explored the characteristics of this effect, which has been rarely studied in the literature. As the literature does not separate the total effect of LTC institutionalization on medical care utilization into direct and indirect effects, medical care utilization was usually treated as an end outcome to compare, not the underlying mechanism contributing to the final difference between IC users and HC users. To the author's knowledge, this is the first study attempting to break down the total effect of LTC institutionalization on medical utilization into a direct effect and an indirect effect due to health status change, although it had to rely on logical interpretations. Considering that the LTC eligibles have dual needs for social and medical care, the study results that LTC place can differently affect the utilization pattern of medical care services have important meanings. As suggested from the beginning of this chapter, providers of IC

services may have incentives to reduce both outpatient and inpatient medical service utilization of their residents especially when the quasi-market environment surrounding them is characterized by several common features found in various health and long-term care systems. Korean LTC system shares various features affecting these findings, such as compensating IC services based on per-diem payments, the inadequate balance of IC/HC service supply which could contribute to the waiting lines, insufficient policies regarding the quality of IC services, and the absence of coordination mechanism such as person-centered blended payments which could foster accountability of providers regarding integrated care delivery (Amelung et al., 2017; Gori et al., 2015). My study results show that this type of negative direct effect of LTC institutionalization on medical utilization exists in the Korean context.

One of the key contributions of this study would be that I have shown that the consequence of the negative direct effect of LTC institutionalization on medical utilization could work in both ways – it could result in unmet medical needs and also in efficiency gain. Combining the result of this chapter that the negative direct effect of LTC institutionalization on outpatient service utilization exists and the result of the previous chapter that LTC institutionalization increases preventable hospitalization, it seems evident that IC users face the unmet needs in primary health care compared to HC users. However, results of this chapter suggesting that LTC institutionalization can delay the entrance of LTCH and reduce the number of acute hospital admissions during the end-of-life period show it could also result in a gain in efficiency, especially among the severest ones. This ambivalence seems to affect users

differently according to their initial health status. As the public health framework for healthy ageing (WHO, 2015) suggests, less severe ones could be more highly affected by the unmet needs in primary care as they are more susceptive to prevention and management of chronic medical conditions. On the other hand, the severest persons could benefit more from efficiency gains in the management of their conditions, as the focus of care shifts from intensive medical cure to more support on ensuring a dignified later life (WHO, 2015). In short, two sides of the direct effect seem to affect the severe and the mild differently, partly explaining the differential effect of LTC place on health and formal health care costs. However, with regard to the latter aspect, care must be taken to ensure that these cost savings do not come at the expense of people-centered service quality. In that sense, the direct effects among the severest may also be outweighed by the negative effects of worsening patient experience, rather than the positive effects of cost savings.

This study further investigated which are the major disease categories where the negative direct effect of LTC institutionalization on medical utilization had occurred, by subdividing the costs of NHI services according to the type of services (outpatient, LTCH admission, acute hospital admission, and other hospital admissions) and primary diagnosis of service utilization. Several fruitful findings came out from this analysis. First, HC users received more intensive treatments for cancer. This was found in all types of services from outpatient services to acute hospital admissions, and it was also consistent in an additional

analysis using acute hospital admissions in the last 90 days of life[38]. This result shows that the negative direct effect of LTC institutionalization may have potential gain in efficiency regarding end-of-life cancer treatments, although there also exists the chance of unmet medical needs related to cancer. As this study used data before the national introduction of home-based hospice services in 2020 (Park et al., 2022), further studies are required using more updated data. Second, IC users may suffer from unmet medical needs due to several diseases such as chronic kidney disease or conditions affecting the mobility and physical functions of older persons. HC users tend to receive more outpatient services due to chronic kidney disease (303,037 WON in the whole sample), and even though IC users utilized more inpatient services regarding chronic kidney disease (86,722 WON for acute hospital admission and 30,992 WON for other inpatient services), total utilization was smaller even after adjusting medical care utilization before entering LTC services (Appendix 5.9). Moreover, HC users generally utilized more medical services due to musculoskeletal diseases, and they have received more acute hospital services regarding palliative & rehabilitative care services among grade 1-2 samples. This may have been one of the factors mediating the effect of LTC institutionalization on ADL/IADL degradation, which is an area that requires further research. Third, the quality of IC services regarding manageable conditions such as infection control, and skin and wound care requires further investigation. Although it is hard to tell whether the positive total effect of LTC institutionalization on acute hospital admissions due to diseases such as pneumonia, tuberculosis, or decubitus ulcer could be interpreted as a direct

[38] Available on request.

effect implying failure in manageable conditions, the fact that these are the only disease categories which have shown positive total effect among grade 1-2 samples should gain more interest. This issue has recently gained wide interest in relation with COVID-19 (Konetzka et al., 2021), but the comparison between LTC places is seldom studied. Finally, the prevention of dementia and management of behavioral and psychological symptoms of dementia (BPSD) is important. As shown in table 4.2, IC users are more prone to ending up using LTCH services compared to HC users (although it seems to postpone the point of entry), and dementia explains most of this. This may be due to the fact that LTC institutionalization deteriorates cognitive capacity as shown from the results in the previous chapter, and also could be related to insufficient quality of IC services related to BPSD managements in Korea.

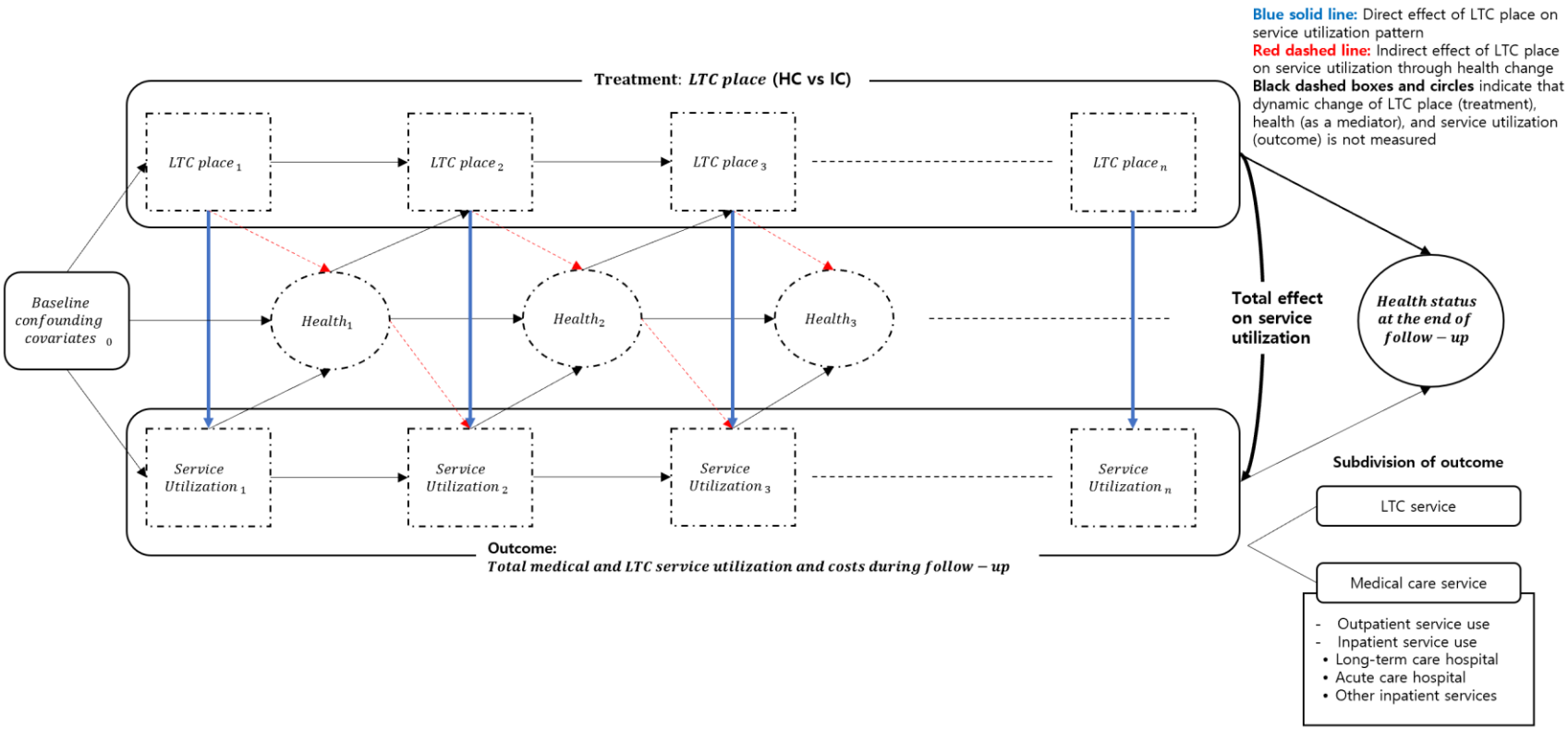
This study has several limitations. First, this study shares the same methodological limitations explained in the previous chapter, which makes it hard to interpret the results of this study as causal relations. However, due to the rich dataset measuring covariates such as income levels, functional ability, cognitive capacity, and informal caregiving which are not often available in medical claim data, this study was able to control key conceptual confounders regarding the research question (See chapter 3 for details). Second, disentangling total effects into direct and indirect effects had relied on logical interpretation, which is based on several assumptions. This study has concluded that as the final health status observed at the end of follow-up is worse among the IC users, institutional care may have a positive indirect effect on medical utilization and thereby the negative total effect could be interpreted as the existence of a negative direct effect. This interpretation is true

under two assumptions. One assumption is that all else being equal, poorer health will increase medical utilization. A review study revealed that needs factors such as disease severity, symptom severity, comorbidity, and complications increase medical utilization, although degradation in physical functions could have the opposite effect (de Boer et al., 1997). The finding that medical utilization mediated by a joint health status of death, ADLs, IADLs, and cognitive function was positive in the supplemental causal mediation analysis may support this assumption (Appendix 5.1), although further studies might clarify this assumption. Another assumption is that the health status measured at the end of the follow-up reflects the overall health status during the follow-up period. Based on the dynamic model shown in Figure 5.1, the total direct and indirect effects during the follow-up period can be seen as the sum of the direct and indirect effects that occurred at each time point, respectively. The claim that the sum of these point indirect effects has a positive value requires the assumption that overall health status during the follow-up period is better among HC users compared to IC users, which can hold if the area under the health status trajectory curve is larger among HC users[39]. I would like to argue that this assumption could be satisfied at least from the population average perspective, based on the literature suggesting that health decline in the older adult population is a gradual process (Calderon-Larranaga et al., 2021) and the results of additional Kaplan-Meier curve drawn from the study data using time-to death as a dependent variable (Appendix 5.10). The Kaplan-Meier curve showed that IC users generally had higher mortality rates compared

[39] This can be thought of as comparing the area of two shapes that have the same height on the left side and different heights on the right side.

to HC users throughout the follow-up period. Third, using logical interpretation also means that it is hard to identify whether the direct effect exists when the total effect is positive and that the size of the total effects cannot be interpreted as the magnitude of the direct effect even when the negative total effect was present. Even though further causal mediation analysis had revealed that the negative direct effect of long-term care institutionalization exists (Appendix 5.1), this result should be interpreted with caution as there exists methodological limitation in the analysis. Although the consistency in two different analyses – a logical interpretation using total effects and causal mediation analysis supports the robustness of results, given the aforementioned assumptions in the logical interpretation process, it is important to be careful with the results of this part of the study. Fourth, analyzing the effect on medical care services that are uncovered by NHI and the effect on informal caregiving was not possible due to lack of data. Only a rough interpretation incorporating descriptive results from other studies was possible. Therefore, it should be noted that interpretation regarding uncovered medical services and informal caregiving did not adjust baseline differences regarding the choice of LTC place.

Figure 5.1. Complex relation between LTC place, health, and medical service utilization and conceptual decomposition of direct and indirect effects



* HC: home and community based care; IC: institutional care; LTC: long−term care

[Table 5.1] Difference in formal care costs due to LTC place (covariate adjusting EB weights applied)

	Total		Grade 1-2		Grade 3-4		Grade 5	
	HC	IC-HC	HC	IC-HC	HC	IC-HC	HC	IC-HC
0. LTCI + NHI service	13,395,710	5,360,384**	14,720,750	4,439,131**	13,599,464	5,484,595**	11,882,651	5,148,176**
	(23,962)	(133,394)	(118,608)	(301,268)	(27,256)	(174,401)	(43,025)	(259,697)
1. LTCI service	7,099,631	4,768,214**	5,715,315	5,962,660**	7,155,070	5,060,736**	7,548,685	2,624,986**
	(9,809)	(68,255)	(42,333)	(162,038)	(10,902)	(84,158)	(24,294)	(165,403)
2. NHI service	6,296,880	591,370**	9,004,296	-1,522,389**	6,405,507	423,746*	4,334,356	2,522,800**
	(24,367)	(143,399)	(119,686)	(298,378)	(27,763)	(186,906)	(42,327)	(279,415)
2.1 Outpatient service	1,552,027	-664,823**	1,420,899	-634,272**	1,654,245	-728,047**	1,129,739	-333,196**
	(7,873)	(25,135)	(27,583)	(48,791)	(9,667)	(35,579)	(10,575)	(26,713)
2.2 Inpatient service	4,744,853	1,256,193**	7,583,396	-888,117**	4,751,262	1,151,793**	3,204,617	2,855,996**
	(22,368)	(138,505)	(114,877)	(293,674)	(25,102)	(178,468)	(40,281)	(278,950)

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC-HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW).

* If coefficient of 'IC-HC (treatment variable)' is statistically significantly different with 0, **, p-value<0.01; *, p-value<0.05; +, p-value<0.1.

* Subjects who are switch users (used both services within follow-up period) were removed from the study sample. See appendix 4.1 for other verifications.

* LTC: Long-term care; EB: Entropy balancing; LTCI: Long-term care insurance; NHI: National health insurance

[Table 5.2] Difference in NHI service utilization, due to LTC place (covariate adjusting EB weights applied)

	Total		Grade 1-2		Grade 3-4		Grade 5	
	HC	IC-HC	HC	IC-HC	HC	IC-HC	HC	IC-HC
1. Outpatient visits	35.2 (0.1)	-7.4 (0.3) **	31.5 (0.3)	-3.9 (0.7) **	36.4 (0.1)	-8.0 (0.3) **	31.4 (0.2)	-5.9 (0.6) **
2. Inpatient days	33.8 (0.2)	15.7 (0.9) **	62.1 (0.8)	-0.4 (2.0)	33.0 (0.2)	14.3 (1.1) **	22.8 (0.3)	29.1 (2.5) **
2.1 LTCH admission days	17.0 (0.1)	11.0 (0.8) **	28.7 (0.6)	1.4 (1.6)	16.3 (0.1)	9.9 (0.9) **	14.3 (0.3)	20.5 (2.3) **
2.2 Acute hospital admission days	12.7 (0.1)	1.5 (0.4) **	26.5 (0.4)	-3.2 (1.1) **	12.6 (0.1)	1.5 (0.5) **	5.9 (0.1)	4.1 (0.7) **
2.3 Other inpatient days	4.1 (0.0)	3.2(0.3) **	6.9 (0.3)	1.5 (0.8) +	4.1 (0.1)	2.9 (0.4) **	2.6 (0.1)	4.5 (0.8) **

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC-HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using number of outpatient visits or inpatient days.

* If coefficient of 'IC-HC (treatment variable)' is statistically significantly different with 0, **, p-value<0.01; *, p-value<0.05; +, p-value<0.1.

* Subjects who are switch users (used both services within follow-up period) were removed from the study sample. Results applying other verifications available on request.

* LTC: Long-term care; EB: Entropy balancing; LTCI: Long-term care insurance; NHI: National health insurance

[Table 5.3] Difference in LTCH and end-of-life acute hospital admission due to LTC place (covariate adjusting EB weights applied)

		Formal care costs		Pr (utilization=1)		Formal care costs (utilization=1)		Inpatient days (utilization=1)	
		HC	IC-HC	HC	IC-HC	HC	IC-HC	HC	IC-HC
LTCH use	Total	1,290,893	721,341**	0.144	0.131**	8,978,458	-1,663,961**	99.96	-10.57**
		(10,391)	(58,432)	(0.001)	(0.005)	(54,834)	(170,977)	(0.57)	(2.02)
	Grade 1-2	2,084,042	-71,501	0.194	0.071**	10,723,094	-3,148,845**	109.4	-24.69**
		(56,275)	(127,607)	(0.003)	(0.009)	(227,225)	(411,901)	(2.09)	(4.06)
	Grade 3-4	1,237,485	651,784**	0.142	0.122**	8,725,320	-1,565,146**	97.72	-10.86**
		(11,374)	(68,159)	(0.001)	(0.006)	(60,651)	(208,341)	(0.64)	(2.4)
	Grade 5	1,142,832	1,429,706**	0.127	0.209**	9,005,227	-1,337,909**	104.93	-6.6
		(22,554)	(175,623)	(0.002)	(0.014)	(129,188)	(421,800)	(1.45)	(5.15)
Acute Hospital use during last 90 days of life	Total	5,954,468	-1,209,122**	0.634	-0.052**	9,386,023	-1,237,808**	22.23	-1.87**
		(65,564)	(220,293)	(0.003)	(0.012)	(91,326)	(325,806)	(0.18)	(0.67)
	Grade 1-2	5,809,574	-1,383,706**	0.59	-0.024	9,844,193	-2,028,202**	23.45	-2.05+
		(182,269)	(343,781)	(0.009)	(0.022)	(273,204)	(500,694)	(0.53)	(1.22)
	Grade 3-4	6,073,705	-1,359,944**	0.646	-0.066**	9,401,501	-1,271,954**	22.32	-2.24**
		(73,710)	(272,430)	(0.004)	(0.015)	(100,669)	(410,206)	(0.2)	(0.86)
	Grade 5	4,951,453	141,875	0.611	-0.001	8,104,375	250,336	18.51	2.04
		(196,489)	(846,772)	(0.012)	(0.046)	(282,539)	(1,225,605)	(0.6)	(2.42)

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC-HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW), probability, and inpatient days.

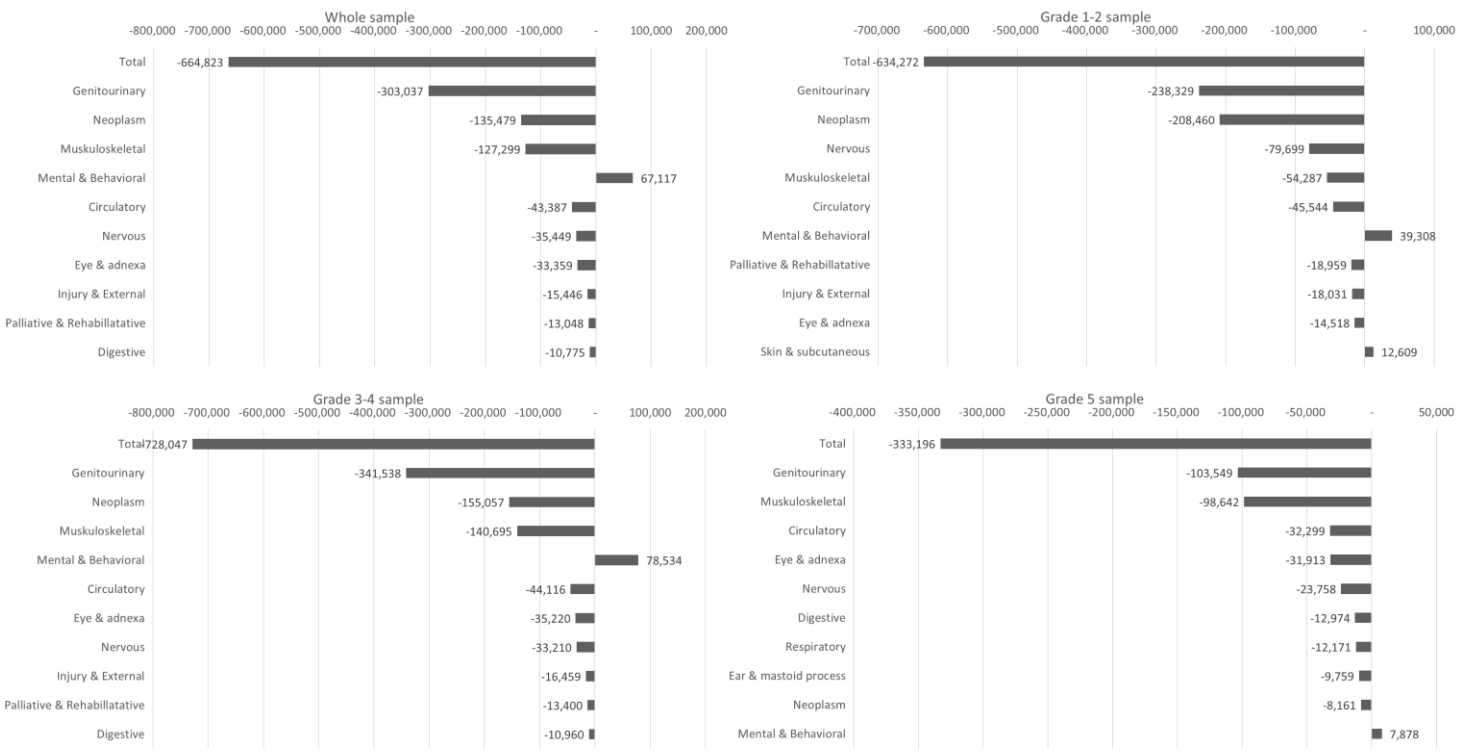
* If coefficient of 'IC-HC (treatment variable)' is statistically significantly different with 0, **, p-value<0.01; *, p-value<0.05; +, p-value<0.1.

* Subjects who are switch users (used both services within follow-up period) were removed from the study sample. See appendix 4.5 for other verifications.

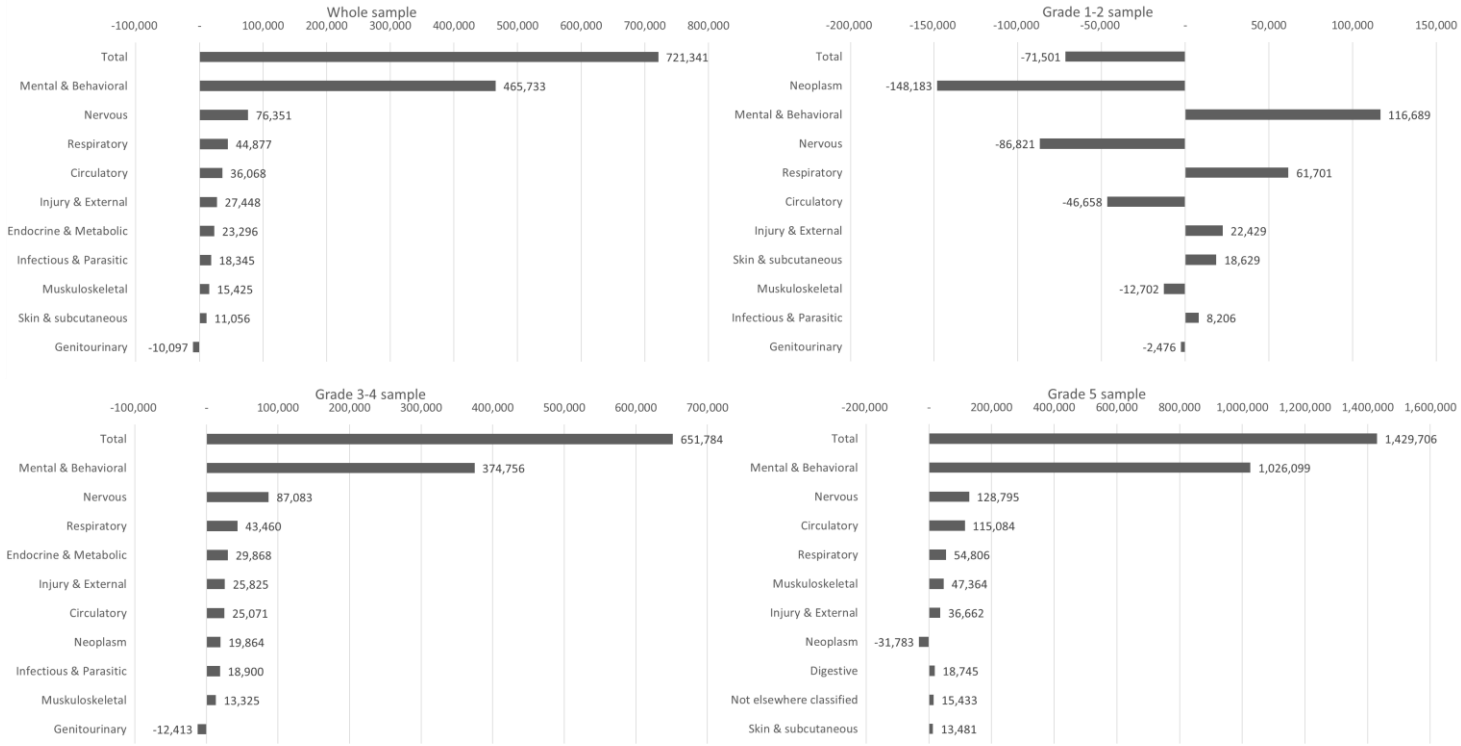
* LTC: Long-term care; EB: Entropy balancing; LTCI: Long-term care insurance; NHI: National health insurance; LTCH: Long-term care hospital

Figure 5.2. Comparison of top 10 largest cost differences by LTC place, by dividing causes of medical utilization (using ICD-10 Chapters)

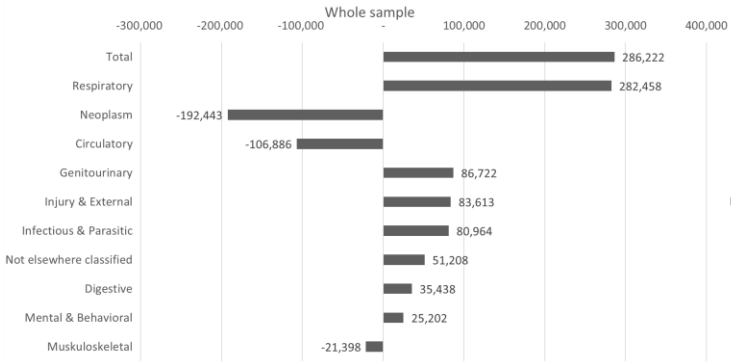
Panel A. Average annual outpatient service cost difference by LTC place

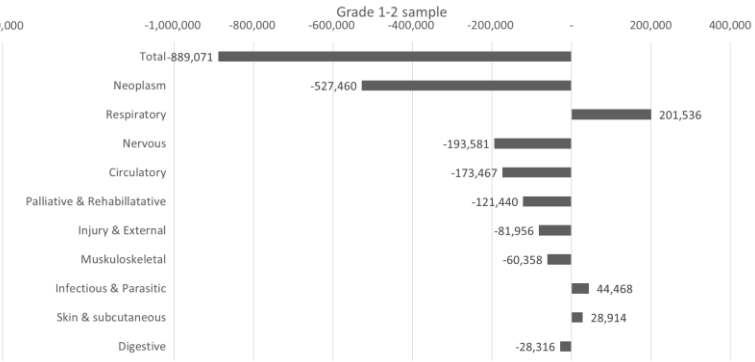


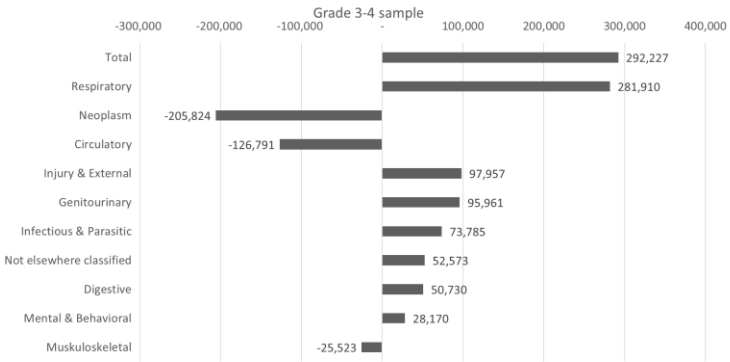
Panel B. Average annual LTCH service cost difference by LTC place

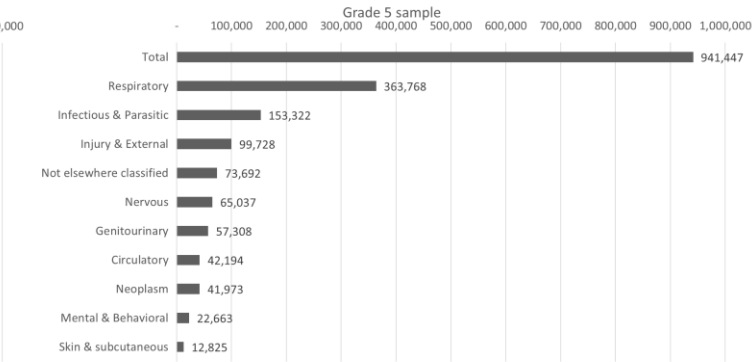


Panel C. Average annual acute hospital service cost difference by LTC place

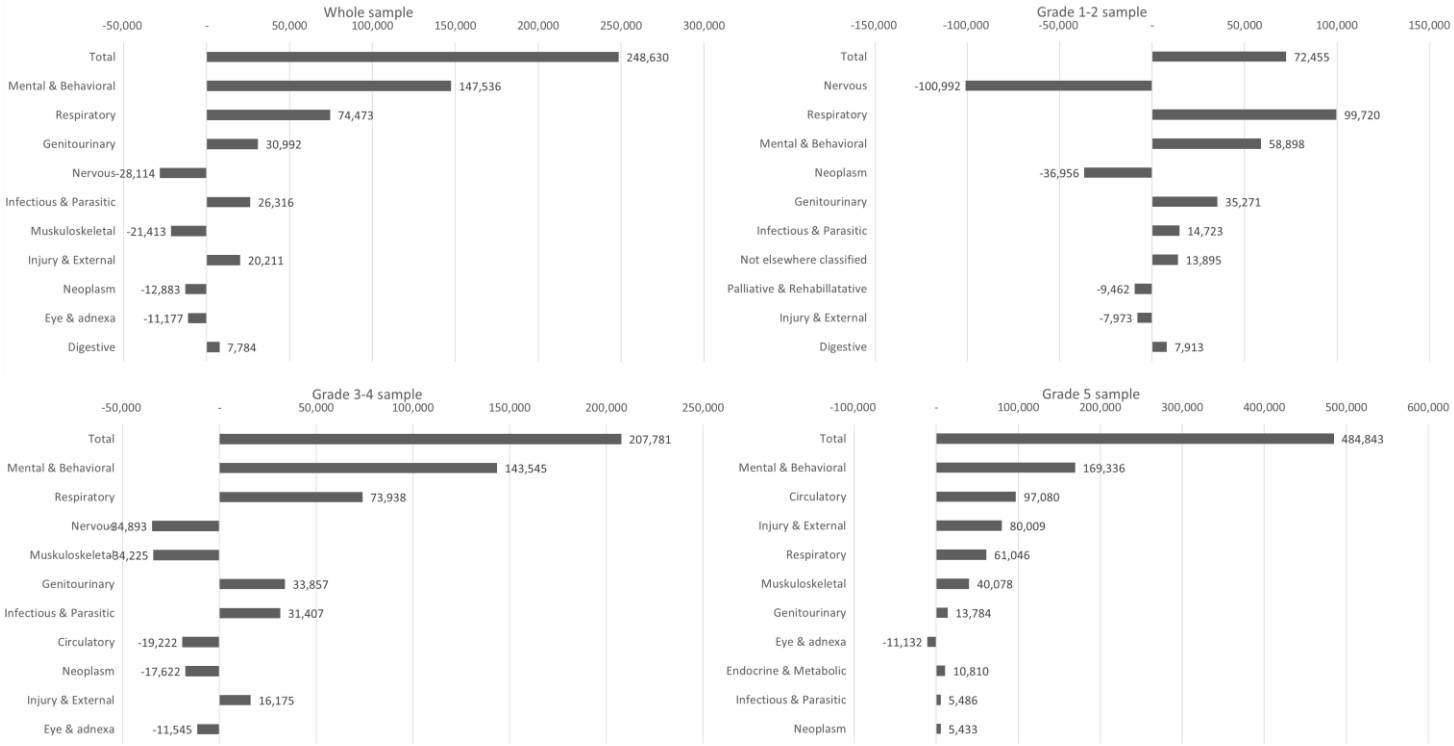








Panel D. Average annual other hospital service cost difference by LTC place



* Entropy balancing weight adjusted outpatient and inpatient costs divided by primary cause of the medical care utilization were compared among IC and HC users.
* Costs among IC users minus HC users are suggested.
* IC: Institutional care group; HC: Home and community based care group.

* Subjects who are switch users (used both services within follow-up period) were removed from the study sample. See Appendix 4.6 for other verifications.
* Diseases were categorized as follows, in accordance with ICD-10 chapters
('Chapter 21. Factors influencing health status and contact with health services' was named palliative & rahabillatative in the figure as most conditions claimed under this chapter were consisted of palliative or rehabillatative services among study sample)

Infectious & Parasitic (Chapter 1. A00-B99)	Neoplasm (Chapter 2. C00-D48)
Blood & Immune (Chapter 3. D50-D89)	Endocrine & Metabolic (Chapter 4. E00-E90)
Mental & Behavioral (Chapter 5. F00-F99)	Nervous (Chapter 6. G00-G99)
Eye & adnexa (Chapter 7. H00-H59)	Ear & mastoid process (Chapter 8. H60-H95)
Circulatory (Chapter 9. I00-I99)	Respiratory (Chapter 10. J00-J99)
Digestive (Chapter 11. K00-K93)	Skin & subcutaneous (Chapter 12. L00-L99)
Muskuloskeletal (Chapter 13. M00-M99)	Genitourinary (Chapter 14. N00-N99)
Pregnancy & birth (Chapter 15. O00-O99)	Perinatal (Chapter 16. P00-P96)
Congenital (Chapter 17. Q00-Q99)	Not elsewhere classified (Chapter 18. R00-R99)
Injury & external (Chapter 19. S00-T98)	External morbidity/mortality (Chapter 20. V01-Y98)
Palliative & rehabillatative (Chapter 21. Z00-Z99)	Specific purposes (Chapter 22. U00-U99)

References

Amelung, V., Stein, V., Goodwin, N., Balicer, R., Nolte, E., & Suter, E. (2017). Handbook integrated care. Springer.

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020, Sep). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. Journal of Health Economics, 73, Article 102354. https://doi.org/10.1016/j.jhealeco.2020.102354

Blackburn, J., Locher, J. L., & Kilgore, M. L. (2016). Comparison of long-term care in nursing homes versus home health: costs and outcomes in Alabama. The Gerontologist, 56(2), 215-221.

Bremer, P., Challis, D., Hallberg, I. R., Leino-Kilpi, H., Saks, K., Vellas, B., Zwakhalen, S. M., Sauerland, D., & Consortium, R. (2017). Informal and formal care: Substitutes or complements in care for people with dementia? Empirical evidence for 8 European countries. Health Policy, 121(6), 613-622.

Calderón-Larrañaga, A., Hu, X., Haaksma, M., Rizzuto, D., Fratiglioni, L., & Vetrano, D. L. (2021, Aug 12). Health trajectories after age 60: the role of individual behaviors and the social context. Aging (Albany NY), 13(15), 19186-19206. https://doi.org/10.18632/aging.203407

Carter, M. W. (2003). Factors associated with ambulatory care—sensitive hospitalizations among nursing home residents. Journal of Aging and Health, 15(2), 295-331.

Chandra, A., & Skinner, J. (2012). Technology growth and expenditure growth in health care. Journal of Economic Literature, 50(3), 645-680.

Chappell, N. L., Dlitt, B. H., Hollander, M. J., Miller, J. A., & McWilliam, C. (2004). Comparative costs of home care and residential care. The Gerontologist, 44(3), 389-400.

Chon, Y.-h. (2020). The meaning and challenges of the introduction of the Customized Care Services for Older Adults. Journal of the Korea Gerontological Society, 40(4), 599-616.

Coe, N. B., Skira, M. M., & Larson, E. B. (2018). A comprehensive measure of the costs of caring for a parent: differences according to functional status. Journal of the American Geriatrics Society, 66(10), 2003-2008.

Colombo, F., Llena-Nozal, A., Mercier, J., & Tjadens, F. (2011). Help Wanted? https://doi.org/doi:https://doi.org/10.1787/9789264097759-en

Corder, M. R. (2017). Comparing total expenditures by source of long-term services and supports.

de Bienassis, K., Llena-Nozal, A., & Klazinga, N. S. (2020). The economics of patient safety Part III: long-term care: valuing safety for the long haul.

de Boer, A. G., Wijker, W., & de Haes, H. C. (1997). Predictors of health care utilization in the chronically ill: a review of the literature. Health

Policy, 42(2), 101-115.

Duan-Porter, W., Ullman, K., Rosebush, C., McKenzie, L., Ensrud, K. E., Ratner, E., Greer, N., Shippee, T., Gaugler, J. E., & Wilt, T. J. (2020). Interventions to prevent or delay long-term nursing home placement for adults with impairments—A systematic review of reviews. Journal of general internal medicine, 35(7), 2118-2129.

Felix, H. C., Mays, G. P., Stewart, M. K., Cottoms, N., & Olson, M. (2011). Medicaid savings resulted when community health workers matched those with needs to home and community care. Health Affairs, 30(7), 1366-1374.

Gori, C., Fernandez, J.-L., & Wittenberg, R. (2015). Long-term care reforms in OECD countries. Policy Press.

Groenvynck, L., Fakha, A., de Boer, B., Hamers, J. P. H., van Achterberg, T., van Rossum, E., & Verbeek, H. (2022, Aug 12). Interventions to Improve the Transition From Home to a Nursing Home: A Scoping Review. Gerontologist, 62(7), e369-e383. https://doi.org/10.1093/geront/gnab036

Gruber-Baldini, A. L., Stuart, B., Zuckerman, I. H., Simoni-Wastila, L., & Miller, R. (2007). Treatment of dementia in community-dwelling and institutionalized medicare beneficiaries. Journal of the American Geriatrics Society, 55(10), 1508-1516.

Haas-Wilson, D. (2001). Arrow and the information market failure in health care: the changing content and sources of health care information. Journal of health politics, policy and law, 26(5), 1031-1044.

Hollander, M. J., & Chappell, N. L. (2007). A comparative analysis of costs to government for home care and long-term residential care services, standardized for client care needs. Canadian Journal on Aging/La Revue canadienne du vieillissement, 26(S1), 149-161.

Hwang, R. I., & Pak, S. Y. (2019). Status and trend of home health nursing for long-term care insurance beneficiaries. Journal of East-West Nursing Research, 25(2), 157-165.

Kim, H., & Kwon, S. (2021). A decade of public long-term care insurance in South Korea: Policy lessons for aging countries. Health Policy, 125(1), 22-26.

Kim, H. B., & Lim, W. (2015). Long-term care insurance, informal care, and medical expenditures. Journal of Public Economics, 125, 128-142.

Kitchener, M., Ng, T., Miller, N., & Harrington, C. (2006). Institutional and community—Based long-term care: A comparative estimate of public costs. Journal of health & social policy, 22(2), 31-50.

Konetzka, R. T., White, E. M., Pralea, A., Grabowski, D. C., & Mor, V. (2021). A systematic review of long-term care facility characteristics associated with COVID-19 outcomes. Journal of the American Geriatrics Society, 69(10), 2766-2777.

König, H.-H., Leicht, H., Brettschneider, C., Bachmann, C., Bickel, H., Fuchs, A., Jessen, F., Köhler, M., Luppa, M., & Mösch, E. (2014). The costs of dementia from the societal perspective: is care provided in the community really cheaper than nursing home care? Journal of the American

Medical Directors Association, 15(2), 117-126.

Kwon, J., Lee, J.-S., & Han, E.-J. (2012). Magnitude and its effected factors of non-covered services expenditures among long-term care facilities benefits user in Long-term Care Insurance. Health Policy and Management, 22(1), 145-162.

Kwon, S. (2003). Payment system reform for health care providers in Korea. Health policy and planning, 18(1), 84-92.

Kwon, S., Kim, T., Yun, S., & Song, Y. (2019). Development of costing methodology for adequate pricing of long-term care services study.

Kwon, S., Seok, J., Cho, Y., Yun, S., & Kim, K. (2021). Study on policy development for Improving the sustainability of the long-term care insurance.

Lee, J.-S., Kwon, J., Kim, J., Lee, S., Lee, H. S., Seon, J. Y., & Hwang, R. I. (2021). Development of Visiting Nursing for Long-Term Care Insurance for the Elderly.

Marek, K. D., Stetzer, F., Adams, S. J., Popejoy, L. L., & Rantz, M. (2012). Aging in place versus nursing home care: Comparison of costs to Medicare and Medicaid. Research in gerontological nursing, 5(2), 123-129.

Metzelthin, S. F., Verbakel, E., Veenstra, M. Y., Van Exel, J., Ambergen, A. W., & Kempen, G. I. (2017). Positive and negative outcomes of informal caregiving at home and in institutionalised long-term care: a cross-sectional study. BMC geriatrics, 17(1), 1-10.

Mitchell, S. L., Morris, J. N., Park, P. S., & Fries, B. E. (2004). Terminal care for persons with advanced dementia in the nursing home and home care settings. Journal of palliative medicine, 7(6), 808-816.

Mittelman, M. S., Haley, W. E., Clay, O. J., & Roth, D. L. (2006). Improving caregiver well-being delays nursing home placement of patients with Alzheimer disease. Neurology, 67(9), 1592-1599.

Na, Y.-K., & Jeong, H.-S. (2019). Analysis of wage determinants of care workers. Health Policy and Management, 29(4), 496-501.

NHIS. (2020). Survey on medical expenses of NHI patients, 2020.

NHIS. (2022). Long-term care insurance statistical yearbook 2021.

Norton, E. C. (2016). Chapter 16 - Health and Long-Term Care. In J. Piggott & A. Woodland (Eds.), Handbook of the Economics of Population Aging (Vol. 1, pp. 951-989). North-Holland. https://doi.org/https://doi.org/10.1016/bs.hespa.2016.06.001

Ouslander, J. G., Lamb, G., Perloe, M., Givens, J. H., Kluge, L., Rutland, T., Atherly, A., & Saliba, D. (2010). Potentially Avoidable Hospitalizations of Nursing Home Residents: Frequency, Causes, and Costs: [See editorial comments by Drs. Jean F. Wyman and William R. Hazzard, pp 760–761]. Journal of the American Geriatrics Society, 58(4), 627-635.

Park, Y.-T., Kim, D., Koh, S.-J., Kim, Y. S., & Kim, S. M. (2022). Patient Factors Associated with Different Hospice Programs in Korea: Analyzing Healthcare Big Data. International Journal of Environmental Research and Public Health, 19(3), 1566.

Pearl, J. (2012). The causal mediation formula—a guide to the assessment of pathways and mechanisms. Prevention science, 13, 426-436.

Rigler, S. K., Perera, S., Jachna, C., Shireman, T. I., & Eng, M.

(2004). Comparison of the association between disease burden and inappropriate medication use across three cohorts of older adults. The American journal of geriatric pharmacotherapy, 2(4), 239-247.

Rijnhart, J. J., Lamp, S. J., Valente, M. J., MacKinnon, D. P., Twisk, J. W., & Heymans, M. W. (2021). Mediation analysis methods used in observational research: a scoping review and recommendations. BMC medical research methodology, 21(1), 1-17.

Sands, L. P., Xu, H., Weiner, M., Rosenman, M. B., Craig, B. A., & Thomas III, J. (2008). Comparison of resource utilization for Medicaid dementia patients using nursing homes versus home and community based waivers for long-term care. Medical care, 46(4), 449-453.

Schwarzkopf, L., Menn, P., Leidl, R., Graessel, E., & Holle, R. (2013). Are community-living and institutionalized dementia patients cared for differently? Evidence on service utilization and costs of care from German insurance claims data. BMC health services research, 13(1), 1-11.

Shin, Y. (2022). Transition from Community-Based to Institutional Long-Term Care in Korea - A Competing Risks Analysis on National Health Insurance Data(NHID) -. Korean Journal of Social Welfare, 74(3), 31-62.

Shireman, T. I., & Rigler, S. K. (2004). Penny wise, pound wise: a comparison of Medicaid expenditures for home and community-based services versus nursing facility care for older adults. Home Health Care Services Quarterly, 23(4), 15-28.

Steen, J., Loeys, T., Moerkerke, B., & Vansteelandt, S. (2017). Medflex: an R package for flexible mediation analysis using natural effect models. Journal of Statistical Software, 76, 1-46.

Teri, L., Gibbons, L. E., McCurry, S. M., Logsdon, R. G., Buchner, D. M., Barlow, W. E., Kukull, W. A., LaCroix, A. Z., McCormick, W., & Larson, E. B. (2003). Exercise plus behavioral management in patients with Alzheimer disease: a randomized controlled trial. Jama, 290(15), 2015-2022.

VanderWeele, T., & Vansteelandt, S. (2013). Mediation analysis with multiple mediators. Epidemiologic methods, 2(1), 95-115.

VanderWeele, T., & Vansteelandt, S. (2009). Conceptual issues concerning mediation, interventions and composition. Statistics and its Interface, 2(4), 457-468.

Wennberg, J. E., Fisher, E. S., & Skinner, J. S. (2002). Geography And The Debate Over Medicare Reform: A reform proposal that addresses some underlying causes of Medicare funding woes: geographic variation and lack of incentive for efficient medical practices. Health Affairs, 21(Suppl1), W96-W112.

Werner, R. M., Coe, N. B., Qi, M., & Konetzka, R. T. (2019). Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA internal medicine, 179(5), 617-623.

Chapter 6. Conclusions

Although the current level and speed of ageing may widely differ across countries around the globe, all societies will eventually grow old. According to World Population Prospects 2019, 1 in 6 people in the world will be over the age of 65 by 2050. This is often regarded as a challenge to society, threatening sustainable development. However, various studies reveal that it may not always be the case. As the famous phrase "70 is the new 60" implies, the health of the population from the modernized societies has improved during the past century. More and more policies and activities towards healthy ageing incorporating a life-course approach may accelerate this trend, and along with lifelong education and policies encouraging social participation of the older aged, ageing could be realized as a gift for both individuals and society.

An important life course regarding population ageing would be the stage where the intrinsic capacity of a person starts to decline without dramatic full recovery, often framed as a stage in need of long-term care. Persons who are in this stage of life need care from others to achieve ordinary functioning and to express their preferences. This stage should be distinguished from the end-of-life, which is one of the key messages this study tells. Even if you are in need of long-term care, you could still slow or reverse declines in intrinsic capacity through health services and other capacity enhancing behaviors supported by the enabling environments and social services. This was especially true among the less severe, as the effect of ageing in place (AIP) on health was

greater when initial health status was better. Considering that ageing in place could generally be considered better in terms of person-centeredness and social participation, it means that those who are at the early stage of needing long-term care support could still enjoy their well-being surrounded by their own community. This result that the effect of ageing in place on health could be greater among the less severe also partly explains why there exists a heterogenous effect of ageing in place- it may be due to the study population or the underlying policy settings constructing the study population.

Another important implication of ageing in place is that it can affect the cost during this stage of our lives when our capacities start to decline. As this stage of life could be characterized by dual needs, i.e., both needs for social care services and medical services, it is one of the most costly stages of our life. It is therefore an important goal of the system to efficiently address the needs of older people at this stage of their lifetime. Ageing in place can reduce the cost of care, not only because the cost of institutional care is expensive, but also because it can affect medical utilization. This study has shown that long-term care institutionalization could have a negative direct effect on the medical utilization pattern, where it seems to result in higher medical costs and worse health outcomes due to unmet primary care needs especially among the less severe. Considering the fact that two-thirds of current institutional care users are less severe (with grade 3-5) beneficiaries in South Korea, rebalancing towards ageing in place among the less severe can improve the allocative efficiency of the long-term care system.

On the other hand, there still is some possibility of benefits of

institutional care services, as it seems to result in lower medical costs by substituting less efficient end-of-life acute care among the severest. This means the negative direct effect of long-term care institutionalization on medical utilization patterns could have different meanings among the severest and the less severe. Given that several previous studies have reported that institutionalized patients receive more aggressive symptomatic care than home and community-based patients, the smaller difference in health outcomes among the severely ill compared to the mildly ill may be due to differences in healthcare utilization patterns; among severely ill, the losses from reduced preventive primary care utilization may be small, while the gains from the aggressive implementation of symptomatic care to prevent resident discharge may be large. Moreover, by implementing more intensive symptomatic care, it could result in substituting acute hospital visits which may have less effect among the severest.

However, concerning the effect among the severest ill, care must be taken to ensure that the cost savings do not come at the expense of people-centered service quality. The fact that the severest institutional care users experienced more acute hospital admissions due to manageable medical conditions such as pneumonia, tuberculosis, or decubitus ulcer implies these concerns could be true. In this regard, the quality of institutional care services should be more thoroughly controlled. Moreover, less medical care costs of institutional care users among the severest shown in this study may not be always true. Considering the fact that the results of this study can result from the insufficient supply of home-based advanced care services in Korea such as home-based palliative care services, it may be the context-specific effect

associated with the Korean end-of-life care system.

This study showed that the medical utilization patterns could be affected by ageing in place, which in turn affects health and costs. It means that the mode of health service delivery can construct the context of the effect of ageing in place. For example, in the Korean context where continuity of care is not guaranteed, entering institutional care could result in more reduction of medical utilization. With the fragmented service delivery system where the provider's interest is less connected to patient-centered outcomes, institutional care providers would naturally have incentives to keep their residents longer. A trend that institutional care service users receive more outpatient medical services for dementia control but much less for diseases such as chronic kidney diseases or musculoskeletal diseases could be a meaningful result in this regard. Institutional care providers could be more interested in providing symptom-relieving treatments than longer-term management and prevention. Although not directly analyzed in this study, the quality and availability of home and community based long-term care services could also affect the context of the effect of ageing in place.

The results of this study suggest that rebalancing the health and long-term care system toward ageing in place seems to be the direction to be pursued. At the same time, results of this study that suggest the mode of health and long-term service delivery construct the context affecting the effect of ageing in place imply that an underlying health care delivery system could affect the size of this effect. Investments toward more integrated and person-centered home and community based care can affect both pathways. It could increase the tendency of older persons to choose ageing in

place, and it may also increase the size of the benefit related to ageing in place. Therefore, more person-centered integrated care delivery should be at the heart of policy reforms.

More studies will be needed in order to implement the key policy direction suggested in this study. We will have to move forward to achieve the deinstitutionalization of long-term care, especially among the less severe by increasing investments toward more integrated and person-centered home and community based care. Issues regarding the difference in service utilization due to supplier characteristics using regional variances would further strengthen the need for rebalancing the supply of long-term care services. Unmet medical and non-medical care needs among the less severe might be more efficiently addressed by using services incorporating recent developments such as information and communication technologies, especially when the generation of human resources are inelastic. Studies on financing and policies enabling such balanced supply and utilization according to the needs of the population would be also crucial. For example, person-centered financial structure, such as shared savings or other blended payment schemes is widely discussed in the literature. More studies regarding the quality and types of services regarding this issue would also be beneficial. Finally, studies on equitable access to long-term care services should be reconsidered, as this study has shown that long-term care institutionalization in general results in worse outcomes, and various studies already revealed that factors such as low income or rurality are positively related to long-term care institutionalization.

[Appendix 3.1] English translated questionnaires of modified Kata/Lawton index, and cognition level

1. Please answer the questions about applicant's ability to perform daily activities below

	1	2	3
A1. Bathing			
A2. Getting up from bed (transferring)			
A3. Clothing			
A4. Using the toilet			
A5. Stool and urination control (continence)			
A6. Feeding			
I1. Using the telephone			
I2. Shopping			
I3. Preparing food			
I4. Doing laundry			
I5. Housekeeping			
I6. Using transportation (Bus or metro)			
I7. Handling medications			
I8. Handling finances			
* Note: 1: Can do it alone; 2: Need help; 3: Can't do it at all			

– Questionnaires A1 – A6 were used to measure ADL, and consisted of the items used in Katz index. If the respondent answered 1 (can do it alone), then corresponding item was labeled as independent (1 score). This scoring system referred to Katz et al. (1970), but is not identical as the questionnaires are not exactly the same.

– Questionnaires I1 – I8 were used to measure IADL, and consisted of the items used in Lawton index. Items I1, I4, I5, I6, and I8 were labeled as dependent (0 score) if the respondent answered 3 (can' t do it at all). Items I2, I3, and I7 were labeled as independent (1 score) if the respondent answered 1 (can do it alone). This scoring system referred to Lawton & Brody (1969), but is not identical as the questionnaires are not exactly the same.

2. Please answer the questions about the applicant's cognition symptoms

	Yes	No
C1. Forgets what just happened or heard		
C2. Can't tell the date of today		
C3. Not aware of the place at		
C4. Can't tell the age and birthday		
C5. Can't follow the indications made		
C6. Ability to make judgments are detrimental		
C7. Have communication problems		
C8. Can't calculate numbers		
C9. Can't understand daily schedule		
C10. Can't recognize family or close relatives		

– Numbers of questionnaires answered 'no' is counted and used as a cognition level score

[Appendix 3.2] Balance of baseline covariates before and after weighting: (1) LTC eligibility grade 1−2 subgroup

Treatment 1	No weights			IPTW (logistic model)			IPTW (CBPS)			Entropy balancing weights		
(n=20,355)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	86.03(13.16)	87.45(14.64)	0.10	86.98(13.96)	87.15(14.41)	0.01	86.99(13.98)	87.15(14.41)	0.01	87.14(14.34)	87.14(14.34)	0.00
ADL	0.77(0.78)	0.67(0.73)	-0.14	0.67(0.74)	0.69(0.74)	0.03	0.67(0.74)	0.69(0.73)	0.02	0.69(0.74)	0.69(0.74)	0.00
IADL	1.24(0.75)	1.34(0.75)	0.13	1.3(0.76)	1.31(0.75)	0.02	1.3(0.76)	1.32(0.75)	0.02	1.31(0.75)	1.31(0.75)	0.00
Cognition	3.71(2.18)	4.47(2.4)	-0.33	4.23(2.29)	4.37(2.38)	-0.03	4.21(2.3)	4.3(2.38)	-0.04	4.3(2.38)	4.3(2.38)	0.00
Age	83.87(9.07)	80.48(9.14)	-0.37	81.41(9.25)	81.25(9.22)	-0.02	81.58(9.28)	81.23(9.22)	-0.04	81.23(9.23)	81.23(9.23)	0.00
IC provision	26.9(13.19)	24.05(13.41)	-0.21	24.8(12.65)	24.68(13.65)	-0.01	24.92(12.7)	24.66(13.63)	-0.02	24.68(13.42)	24.68(13.42)	0.00
LH provision	0.18(0.12)	0.2(0.14)	0.16	0.19(0.14)	0.19(0.13)	0.00	0.19(0.14)	0.19(0.13)	0.01	0.19(0.13)	0.19(0.13)	0.00
HC provision	2.04(0.56)	2.08(0.56)	0.08	2.08(0.58)	2.07(0.56)	-0.01	2.08(0.58)	2.07(0.56)	-0.01	2.07(0.56)	2.07(0.56)	0.00
Outpatient visits	23.96(27.98)	36.93(37.04)	0.40	39.22(47.77)	34.16(34.8)	-0.15	35.62(42.94)	34.35(34.92)	-0.04	34.06(35.65)	34.06(35.66)	0.00
Inpatient days: total	41.68(75.1)	49.35(72.64)	0.10	48.05(78.04)	47.84(73.53)	0.00	46.6(76.69)	48.17(73.84)	0.02	47.65(73.26)	47.65(73.27)	0.00
Inpatient days: LH	17.47(57.53)	8.99(39.32)	-0.17	11.83(42.36)	11.08(46.43)	-0.02	11.83(42.5)	11.24(46.84)	-0.01	10.86(44.14)	10.86(44.14)	0.00
2. Binary												
Sex (female=1)	0.6(0.49)	0.51(0.5)	-0.19	0.52(0.5)	0.53(0.5)	0.01	0.52(0.5)	0.53(0.5)	0.01	0.53(0.5)	0.53(0.5)	0.00
Medicaid (=1)	0.08(0.27)	0.07(0.26)	-0.03	0.08(0.27)	0.08(0.26)	-0.02	0.08(0.27)	0.08(0.26)	-0.02	0.07(0.26)	0.07(0.26)	0.00
Disability (=1)	0.25(0.43)	0.35(0.48)	0.21	0.33(0.47)	0.33(0.47)	0.00	0.32(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.00
Dementia (=1)	0.44(0.5)	0.3(0.46)	-0.29	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	-0.01	0.33(0.47)	0.33(0.47)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.18)	0.03	0.03(0.18)	0.03(0.18)	0.00	0.03(0.18)	0.03(0.18)	0.01	0.03(0.18)	0.03(0.18)	0.00
Hypertension (=1)	0.03(0.16)	0.02(0.12)	-0.08	0.02(0.13)	0.02(0.13)	0.00	0.02(0.13)	0.02(0.13)	0.00	0.02(0.13)	0.02(0.13)	0.00
3. Categorical												
Income group 1	0.25(0.43)	0.2(0.4)	-0.12	0.22(0.41)	0.21(0.41)	-0.02	0.22(0.41)	0.21(0.41)	-0.02	0.21(0.41)	0.21(0.41)	0.00
Income group 2	0.12(0.33)	0.09(0.29)	-0.09	0.11(0.31)	0.1(0.3)	-0.02	0.1(0.31)	0.1(0.3)	-0.01	0.1(0.3)	0.1(0.3)	0.00
Income group 3	0.15(0.36)	0.13(0.34)	-0.06	0.13(0.34)	0.13(0.34)	0.01	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	0.00

Income group 4	0.2(0.4)	0.19(0.39)	-0.01	0.19(0.39)	0.19(0.39)	0.01	0.19(0.39)	0.19(0.39)	0.00	0.19(0.39)	0.19(0.39)	0.00
Income group 5	0.29(0.45)	0.39(0.49)	0.22	0.35(0.48)	0.36(0.48)	0.02	0.35(0.48)	0.36(0.48)	0.02	0.37(0.48)	0.37(0.48)	0.00
Cohabitant 1	0.09(0.28)	0.07(0.25)	-0.08	0.08(0.28)	0.07(0.26)	-0.04	0.08(0.27)	0.07(0.26)	-0.02	0.07(0.26)	0.07(0.26)	0.00
Cohabitant 2	0.85(0.36)	0.9(0.3)	0.15	0.87(0.33)	0.89(0.32)	0.04	0.88(0.33)	0.88(0.32)	0.03	0.89(0.32)	0.89(0.32)	0.00
Cohabitant 3	0.06(0.24)	0.04(0.19)	-0.13	0.04(0.2)	0.04(0.2)	-0.01	0.04(0.21)	0.04(0.2)	-0.01	0.04(0.2)	0.04(0.2)	0.00
Caregiver 1	0.01(0.12)	0.01(0.09)	-0.05	0.01(0.11)	0.01(0.1)	-0.03	0.01(0.11)	0.01(0.1)	-0.02	0.01(0.1)	0.01(0.1)	0.00
Caregiver 2	0.88(0.33)	0.92(0.27)	0.15	0.9(0.3)	0.91(0.29)	0.02	0.9(0.3)	0.91(0.29)	0.02	0.91(0.29)	0.91(0.29)	0.00
Caregiver 3	0.11(0.31)	0.07(0.26)	-0.13	0.09(0.28)	0.08(0.27)	-0.02	0.09(0.28)	0.08(0.27)	-0.02	0.08(0.27)	0.08(0.27)	0.00
LTC Grade 1	0.18(0.39)	0.23(0.42)	0.12	0.21(0.41)	0.22(0.41)	0.01	0.22(0.41)	0.22(0.41)	0.01	0.22(0.41)	0.22(0.41)	0.00
LTC Grade 2	0.82(0.39)	0.77(0.42)	-0.12	0.79(0.41)	0.78(0.41)	-0.01	0.78(0.41)	0.78(0.41)	-0.01	0.78(0.41)	0.78(0.41)	0.00
LTC Grade 3	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 4	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 5	–	–	–	–	–	–	–	–	–	–	–	–
CCI 0	0.17(0.38)	0.11(0.32)	-0.16	0.13(0.33)	0.13(0.33)	0.00	0.13(0.34)	0.13(0.33)	-0.01	0.13(0.33)	0.13(0.33)	0.00
CCI 1	0.27(0.44)	0.18(0.39)	-0.21	0.20(0.40)	0.20(0.40)	0.01	0.21(0.40)	0.20(0.40)	0.01	0.20(0.40)	0.20(0.40)	0.00
CCI 2+	0.56(0.50)	0.70(0.46)	0.30	0.67(0.47)	0.67(0.47)	-0.01	0.66(0.47)	0.67(0.47)	-0.01	0.67(0.47)	0.67(0.47)	0.00
Entrance (=2016)	0.33(0.47)	0.32(0.47)	0.00	0.33(0.47)	0.32(0.47)	-0.01	0.33(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.47)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	-0.02	0.32(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.33(0.47)	0.35(0.48)	0.03	0.35(0.48)	0.34(0.48)	0.00	0.34(0.47)	0.35(0.48)	0.00	0.34(0.48)	0.34(0.48)	0.00
Big city area	0.44(0.5)	0.52(0.5)	0.16	0.5(0.5)	0.5(0.5)	0.02	0.5(0.5)	0.5(0.5)	0.02	0.5(0.5)	0.5(0.5)	0.00
City area	0.21(0.4)	0.17(0.37)	-0.10	0.19(0.39)	0.18(0.38)	-0.03	0.19(0.39)	0.18(0.38)	-0.02	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.35(0.48)	0.31(0.46)	-0.09	0.32(0.46)	0.32(0.47)	0.01	0.32(0.47)	0.32(0.47)	0.00	0.32(0.47)	0.32(0.47)	0.00
Treatment 2	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=21,855)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	86.03(13.16)	87.27(14.49)	0.09	86.82(13.83)	87.02(14.3)	0.01	86.83(13.85)	87.02(14.3)	0.01	87.02(14.24)	87.02(14.24)	0.00
ADL	0.77(0.78)	0.68(0.73)	-0.12	0.68(0.74)	0.69(0.74)	0.02	0.68(0.75)	0.69(0.74)	0.01	0.69(0.74)	0.69(0.74)	0.00

IADL	1.24(0.75)	1.33(0.76)	0.13	1.31(0.76)	1.31(0.75)	0.01	1.3(0.76)	1.32(0.75)	0.02	1.31(0.76)	1.31(0.76)	0.00
Cognition	3.71(2.18)	4.42(2.39)	-0.31	4.2(2.28)	4.27(2.36)	-0.03	4.18(2.29)	4.27(2.36)	-0.04	4.27(2.37)	4.27(2.37)	0.00
Age	83.87(9.07)	80.67(9.12)	-0.35	81.55(9.2)	81.35(9.19)	-0.02	81.69(9.25)	81.34(9.18)	-0.04	81.33(9.2)	81.33(9.2)	0.00
IC provision	26.9(13.19)	24.31(13.4)	-0.19	24.95(12.67)	24.84(13.59)	-0.01	25.06(12.72)	24.82(13.57)	-0.02	24.84(13.4)	24.84(13.4)	0.00
LH provision	0.18(0.12)	0.2(0.14)	0.14	0.19(0.14)	0.19(0.13)	0.01	0.19(0.14)	0.19(0.13)	0.01	0.19(0.13)	0.19(0.13)	0.00
HC provision	2.04(0.56)	2.08(0.56)	0.08	2.08(0.58)	2.07(0.56)	-0.01	2.08(0.58)	2.07(0.56)	-0.01	2.07(0.56)	2.07(0.56)	0.00
Outpatient visits	23.96(27.98)	36.5(36.87)	0.38	38.55(46.8)	33.99(34.84)	-0.14	35.21(42.35)	34.17(34.95)	-0.03	33.92(35.59)	33.92(35.59)	0.00
Inpatient days: total	41.68(75.1)	47.94(71.55)	0.09	46.44(76.04)	46.74(72.48)	0.00	45.38(75.19)	46.91(72.57)	0.02	46.65(72.34)	46.65(72.35)	0.00
Inpatient days: LH	17.47(57.53)	8.94(38.96)	-0.17	11.55(41.71)	10.82(45.44)	-0.01	11.66(42.14)	10.85(45.45)	-0.02	10.69(43.57)	10.69(43.58)	0.00
2. Binary												
Sex (female=1)	0.6(0.49)	0.51(0.5)	-0.18	0.53(0.5)	0.53(0.5)	0.01	0.53(0.5)	0.53(0.5)	0.00	0.53(0.5)	0.53(0.5)	0.00
Medicaid (=1)	0.08(0.27)	0.07(0.26)	-0.04	0.08(0.27)	0.07(0.26)	-0.02	0.08(0.27)	0.07(0.26)	-0.02	0.07(0.26)	0.07(0.26)	0.00
Disability (=1)	0.25(0.43)	0.34(0.47)	0.20	0.32(0.47)	0.32(0.47)	0.00	0.32(0.46)	0.32(0.47)	0.02	0.32(0.47)	0.32(0.47)	0.00
Dementia (=1)	0.44(0.5)	0.31(0.46)	-0.27	0.33(0.47)	0.33(0.47)	0.00	0.34(0.47)	0.33(0.47)	-0.02	0.33(0.47)	0.33(0.47)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.18)	0.03	0.04(0.18)	0.03(0.18)	-0.01	0.03(0.18)	0.03(0.18)	0.00	0.03(0.18)	0.03(0.18)	0.00
Hypertension (=1)	0.03(0.16)	0.02(0.13)	-0.07	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00
3. Categorical												
Income group 1	0.25(0.43)	0.2(0.4)	-0.12	0.22(0.41)	0.21(0.41)	-0.02	0.22(0.41)	0.21(0.41)	-0.02	0.21(0.41)	0.21(0.41)	0.00
Income group 2	0.12(0.33)	0.1(0.29)	-0.09	0.11(0.31)	0.1(0.3)	-0.02	0.1(0.31)	0.1(0.3)	-0.01	0.1(0.3)	0.1(0.3)	0.00
Income group 3	0.15(0.36)	0.13(0.34)	-0.06	0.13(0.34)	0.13(0.34)	0.01	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	0.00
Income group 4	0.2(0.4)	0.19(0.39)	-0.01	0.19(0.39)	0.19(0.39)	0.01	0.19(0.39)	0.19(0.39)	0.00	0.19(0.39)	0.19(0.39)	0.00
Income group 5	0.29(0.45)	0.39(0.49)	0.21	0.35(0.48)	0.36(0.48)	0.02	0.35(0.48)	0.36(0.48)	0.02	0.36(0.48)	0.36(0.48)	0.00
Cohabitant 1	0.09(0.28)	0.07(0.25)	-0.08	0.08(0.28)	0.07(0.26)	-0.04	0.08(0.27)	0.07(0.26)	-0.02	0.07(0.26)	0.07(0.26)	0.00
Cohabitant 2	0.85(0.36)	0.9(0.3)	0.15	0.87(0.33)	0.89(0.32)	0.04	0.88(0.33)	0.89(0.32)	0.03	0.89(0.32)	0.89(0.32)	0.00
Cohabitant 3	0.06(0.24)	0.03(0.18)	-0.13	0.04(0.2)	0.04(0.2)	-0.01	0.04(0.2)	0.04(0.2)	-0.01	0.04(0.2)	0.04(0.2)	0.00
Caregiver 1	0.01(0.12)	0.01(0.09)	-0.06	0.01(0.11)	0.01(0.09)	-0.02	0.01(0.1)	0.01(0.09)	-0.02	0.01(0.09)	0.01(0.09)	0.00

Caregiver 2	0.88(0.33)	0.92(0.27)	0.15	0.91(0.29)	0.91(0.28)	0.02	0.91(0.29)	0.91(0.28)	0.02	0.91(0.28)	0.91(0.28)	0.00
Caregiver 3	0.11(0.31)	0.07(0.26)	-0.14	0.08(0.27)	0.08(0.27)	-0.01	0.08(0.28)	0.08(0.27)	-0.02	0.08(0.27)	0.08(0.27)	0.00
LTC Grade 1	0.18(0.39)	0.23(0.42)	0.11	0.21(0.41)	0.22(0.41)	0.01	0.21(0.41)	0.22(0.41)	0.01	0.22(0.41)	0.22(0.41)	0.00
LTC Grade 2	0.82(0.39)	0.77(0.42)	-0.11	0.79(0.41)	0.78(0.41)	-0.01	0.79(0.41)	0.78(0.41)	-0.01	0.78(0.41)	0.78(0.41)	0.00
LTC Grade 3	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 4	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 5	–	–	–	–	–	–	–	–	–	–	–	–
CCI 0	0.17(0.37)	0.11(0.32)	-0.15	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	-0.01	0.13(0.33)	0.13(0.33)	0.00
CCI 1	0.27(0.44)	0.18(0.39)	-0.20	0.21(0.41)	0.21(0.41)	0.00	0.21(0.41)	0.21(0.40)	-0.01	0.21(0.41)	0.21(0.41)	0.00
CCI 2+	0.57(0.50)	0.70(0.46)	0.28	0.66(0.47)	0.66(0.47)	0.00	0.65(0.48)	0.66(0.47)	0.02	0.66(0.47)	0.66(0.47)	0.00
Entrance (=2016)	0.33(0.47)	0.32(0.47)	0.00	0.33(0.47)	0.32(0.47)	-0.01	0.33(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.47)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	-0.02	0.33(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.33(0.47)	0.34(0.48)	0.02	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00
Big city area	0.44(0.5)	0.51(0.5)	0.15	0.49(0.5)	0.5(0.5)	0.02	0.49(0.5)	0.5(0.5)	0.01	0.5(0.5)	0.5(0.5)	0.00
City area	0.21(0.4)	0.17(0.38)	-0.09	0.19(0.39)	0.18(0.38)	-0.03	0.19(0.39)	0.18(0.38)	-0.02	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.35(0.48)	0.32(0.46)	-0.08	0.32(0.47)	0.32(0.47)	0.01	0.32(0.47)	0.32(0.47)	0.00	0.32(0.47)	0.32(0.47)	0.00
Treatment 3	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=21,855)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	85.87(13.03)	87.45(14.64)	0.11	87(14.04)	87.03(14.31)	0.00	86.94(13.98)	87.05(14.33)	0.01	87.02(14.24)	87.02(14.24)	0.00
ADL	0.77(0.78)	0.67(0.73)	-0.14	0.68(0.75)	0.69(0.74)	0.02	0.68(0.75)	0.69(0.74)	0.01	0.69(0.74)	0.69(0.74)	0.00
IADL	1.26(0.77)	1.34(0.75)	0.11	1.31(0.76)	1.31(0.75)	0.01	1.3(0.76)	1.32(0.75)	0.01	1.31(0.76)	1.31(0.76)	0.00
Cognition	3.76(2.19)	4.47(2.4)	-0.31	4.25(2.31)	4.27(2.37)	-0.01	4.21(2.3)	4.28(2.37)	-0.03	4.27(2.37)	4.27(2.37)	0.00
Age	83.6(8.99)	80.48(9.14)	-0.34	81.4(9.31)	81.35(9.2)	0.00	81.59(9.29)	81.31(9.2)	-0.03	81.33(9.2)	81.33(9.2)	0.00
IC provision	26.91(13.14)	24.05(13.41)	-0.22	25.03(12.69)	24.86(13.7)	-0.01	25.15(12.73)	24.82(13.68)	-0.02	24.84(13.4)	24.84(13.4)	0.00
LH provision	0.18(0.13)	0.2(0.14)	0.15	0.19(0.14)	0.19(0.13)	-0.01	0.19(0.14)	0.19(0.13)	0.00	0.19(0.13)	0.19(0.13)	0.00
HC provision	2.04(0.56)	2.08(0.56)	0.07	2.08(0.57)	2.07(0.56)	-0.01	2.08(0.57)	2.07(0.56)	-0.01	2.07(0.56)	2.07(0.56)	0.00

Outpatient visits	25.96(29.99)	36.93(37.04)	0.33	36.62(43.75)	34.05(34.52)	-0.08	34.8(41.19)	34.23(34.66)	-0.02	33.92(35.59)	33.92(35.59)	0.00
Inpatient days: total	39.53(71.04)	49.35(72.64)	0.14	48.54(78.8)	46.93(72.63)	-0.02	46.45(76.42)	47.4(73.11)	0.01	46.65(72.34)	46.65(72.35)	0.00
Inpatient days: LH	15.21(52.95)	8.99(39.32)	-0.13	11.57(41.93)	10.96(46.07)	-0.01	11.41(41.73)	11.18(46.69)	0.00	10.69(43.57)	10.69(43.58)	0.00
2. Binary												
Sex (female=1)	0.59(0.49)	0.51(0.5)	-0.17	0.53(0.5)	0.53(0.5)	0.01	0.53(0.5)	0.53(0.5)	0.01	0.53(0.5)	0.53(0.5)	0.00
Medicaid (=1)	0.08(0.27)	0.07(0.26)	-0.02	0.08(0.27)	0.07(0.26)	-0.02	0.08(0.27)	0.07(0.26)	-0.01	0.07(0.26)	0.07(0.26)	0.00
Disability (=1)	0.26(0.44)	0.35(0.48)	0.19	0.32(0.47)	0.32(0.47)	0.00	0.32(0.47)	0.32(0.47)	0.01	0.32(0.47)	0.32(0.47)	0.00
Dementia (=1)	0.43(0.5)	0.3(0.46)	-0.28	0.33(0.47)	0.33(0.47)	0.00	0.34(0.47)	0.33(0.47)	-0.01	0.33(0.47)	0.33(0.47)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.18)	0.03	0.03(0.18)	0.03(0.18)	0.01	0.03(0.18)	0.03(0.18)	0.01	0.03(0.18)	0.03(0.18)	0.00
Hypertension (=1)	0.03(0.17)	0.02(0.12)	-0.09	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00
3. Categorical												
Income group 1	0.24(0.43)	0.2(0.4)	-0.11	0.21(0.41)	0.21(0.41)	-0.01	0.21(0.41)	0.21(0.41)	-0.01	0.21(0.41)	0.21(0.41)	0.00
Income group 2	0.12(0.32)	0.09(0.29)	-0.07	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00
Income group 3	0.14(0.35)	0.13(0.34)	-0.04	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	0.00
Income group 4	0.2(0.4)	0.19(0.39)	-0.01	0.19(0.39)	0.19(0.39)	0.00	0.19(0.39)	0.19(0.39)	0.00	0.19(0.39)	0.19(0.39)	0.00
Income group 5	0.3(0.46)	0.39(0.49)	0.18	0.36(0.48)	0.36(0.48)	0.01	0.36(0.48)	0.36(0.48)	0.01	0.36(0.48)	0.36(0.48)	0.00
Cohabitant 1	0.09(0.28)	0.07(0.25)	-0.07	0.08(0.27)	0.07(0.26)	-0.02	0.08(0.27)	0.07(0.26)	-0.01	0.07(0.26)	0.07(0.26)	0.00
Cohabitant 2	0.86(0.35)	0.9(0.3)	0.12	0.88(0.33)	0.89(0.32)	0.02	0.88(0.32)	0.88(0.32)	0.01	0.89(0.32)	0.89(0.32)	0.00
Cohabitant 3	0.05(0.23)	0.04(0.19)	-0.09	0.04(0.2)	0.04(0.2)	0.00	0.04(0.2)	0.04(0.2)	-0.01	0.04(0.2)	0.04(0.2)	0.00
Caregiver 1	0.01(0.11)	0.01(0.09)	-0.04	0.01(0.1)	0.01(0.09)	-0.01	0.01(0.1)	0.01(0.1)	-0.01	0.01(0.09)	0.01(0.09)	0.00
Caregiver 2	0.89(0.31)	0.92(0.27)	0.09	0.91(0.29)	0.91(0.28)	0.01	0.91(0.29)	0.91(0.28)	0.01	0.91(0.28)	0.91(0.28)	0.00
Caregiver 3	0.1(0.29)	0.07(0.26)	-0.08	0.08(0.27)	0.08(0.27)	-0.01	0.08(0.27)	0.08(0.27)	-0.01	0.08(0.27)	0.08(0.27)	0.00
LTC Grade 1	0.18(0.38)	0.23(0.42)	0.12	0.22(0.41)	0.22(0.41)	0.00	0.22(0.41)	0.22(0.41)	0.00	0.22(0.41)	0.22(0.41)	0.00
LTC Grade 2	0.82(0.38)	0.77(0.42)	-0.12	0.78(0.41)	0.78(0.41)	0.00	0.78(0.41)	0.78(0.41)	0.00	0.78(0.41)	0.78(0.41)	0.00
LTC Grade 3	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00
LTC Grade 4	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00

LTC Grade 5	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00	0(0)	0(0)	0.00
CCI 0	0.17(0.38)	0.12(0.32)	-0.15	0.13(0.34)	0.13(0.34)	0.00	0.13(0.34)	0.13(0.34)	-0.01	0.13(0.33)	0.13(0.33)	0.00
CCI 1	0.27(0.44)	0.19(0.39)	-0.19	0.20(0.40)	0.21(0.41)	0.01	0.21(0.41)	0.21(0.40)	-0.01	0.21(0.41)	0.21(0.41)	0.00
CCI 2+	0.56(0.50)	0.69(0.46)	0.28	0.67(0.47)	0.66(0.47)	-0.01	0.66(0.47)	0.66(0.47)	0.01	0.66(0.47)	0.66(0.47)	0.00
Entrance (=2016)	0.33(0.47)	0.32(0.47)	0.00	0.33(0.47)	0.32(0.47)	0.00	0.33(0.47)	0.32(0.47)	0.00	0.32(0.47)	0.32(0.47)	0.00
Entrance (=2017)	0.35(0.48)	0.33(0.47)	-0.03	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.33(0.47)	0.35(0.48)	0.04	0.35(0.48)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00
Big city area	0.44(0.5)	0.52(0.5)	0.17	0.49(0.5)	0.5(0.5)	0.02	0.49(0.5)	0.5(0.5)	0.02	0.5(0.5)	0.5(0.5)	0.00
City area	0.21(0.41)	0.17(0.37)	-0.11	0.19(0.39)	0.18(0.38)	-0.02	0.19(0.39)	0.18(0.38)	-0.02	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.35(0.48)	0.31(0.46)	-0.09	0.32(0.47)	0.32(0.47)	0.00	0.33(0.47)	0.32(0.47)	-0.01	0.32(0.47)	0.32(0.47)	0.00

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow-up period) were treated as RC group

* IPTW: Inverse probability of treatment weighting; CBPS: Covariate balancing propensity score; ADL: Activities of daily living; IADL: Instrumental activities of daily living; LH: Long-term care hospital; CCI: Charlson comorbidity index

* Mean (standard error) was reported for continuous variables and proportion (standard error) was reported for binary and categorical variables

[Appendix 3.2] Balance of baseline covariates before and after weighting: (2) LTC eligibility grade 3-4 subgroup

Treatment 1	No weights			IPTW (logistic model)			IPTW (CBPS)			Entropy balancing weights		
(n=186,087)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	61(7.14)	58.48(6.65)	0.37	58.64(6.67)	58.69(6.74)	0.01	58.9(6.71)	58.68(6.74)	-0.03	58.68(6.73)	58.68(6.73)	0.00
ADL	2.83(0.92)	3.06(0.92)	-0.25	3.02(0.9)	3.04(0.93)	0.02	2.99(0.9)	3.04(0.93)	0.05	3.04(0.93)	3.04(0.93)	0.00
IADL	2.51(1.53)	2.95(1.5)	-0.29	2.87(1.54)	2.91(1.5)	0.02	2.84(1.54)	2.91(1.5)	0.05	2.91(1.51)	2.91(1.51)	0.00
Cognition	4.9(1.84)	4(1.97)	0.58	5.74(1.84)	5.91(2)	-0.09	5.67(1.83)	5.91(2)	-0.13	5.92(1.99)	5.92(1.99)	0.00
Age	83.39(8.54)	81.19(7.93)	0.27	81.54(7.93)	81.37(7.99)	-0.02	81.69(8.1)	81.37(7.99)	-0.04	81.37(8)	81.37(8)	0.00
IC provision	27.28(13.74)	24.54(13.16)	0.20	25.12(12.86)	24.77(13.3)	-0.03	25.27(12.96)	24.77(13.3)	-0.04	24.76(13.23)	24.76(13.23)	0.00
LH provision	0.2(0.13)	0.21(0.14)	-0.11	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.11(0.57)	2.14(0.57)	-0.04	2.15(0.57)	2.14(0.57)	-0.02	2.14(0.57)	2.14(0.57)	-0.01	2.14(0.57)	2.14(0.57)	0.00
Outpatient visits	25.44(30.59)	41(39.45)	-0.44	59.71(76.96)	39.76(38.6)	-0.57	44.91(58.54)	39.88(38.65)	-0.14	39.75(39.04)	39.75(39.05)	0.00
Inpatient days: total	23.76(57.19)	23.34(47.6)	0.01	23.06(49.37)	23.37(48.45)	0.01	23.34(50.66)	23.37(48.41)	0.00	23.38(48.44)	23.38(48.45)	0.00
Inpatient days: LH	10.45(44.18)	5.59(29.2)	0.13	5.8(27.2)	5.98(31.04)	0.00	6.13(28.27)	5.98(31.01)	0.00	5.98(30.71)	5.98(30.71)	0.00
2. Binary												
Sex (female=1)	0.64(0.48)	0.66(0.47)	-0.04	0.63(0.48)	0.65(0.48)	0.06	0.63(0.48)	0.65(0.48)	0.04	0.66(0.48)	0.66(0.48)	0.00
Medicaid (=1)	0.11(0.32)	0.1(0.31)	0.03	0.12(0.32)	0.11(0.31)	-0.03	0.11(0.31)	0.11(0.31)	0.00	0.11(0.31)	0.11(0.31)	0.00
Disability (=1)	0.21(0.41)	0.31(0.46)	-0.23	0.31(0.46)	0.3(0.46)	-0.02	0.29(0.45)	0.3(0.46)	0.02	0.3(0.46)	0.3(0.46)	0.00
Dementia (=1)	0.26(0.44)	0.08(0.27)	0.50	0.11(0.31)	0.09(0.29)	-0.03	0.11(0.31)	0.09(0.29)	-0.03	0.09(0.29)	0.09(0.29)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.19)	-0.04	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.18)	0.02(0.15)	0.06	0.02(0.15)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.28(0.45)	0.23(0.42)	0.10	0.25(0.43)	0.24(0.43)	-0.03	0.24(0.43)	0.24(0.43)	-0.01	0.24(0.43)	0.24(0.43)	0.00
Income group 2	0.12(0.32)	0.09(0.28)	0.09	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.35)	0.12(0.32)	0.06	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	-0.01	0.12(0.33)	0.12(0.33)	0.00

Income group 4	0.18(0.38)	0.18(0.38)	0.01	0.17(0.37)	0.18(0.38)	0.02	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.29(0.45)	0.38(0.49)	-0.20	0.37(0.48)	0.38(0.48)	0.02	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Cohabitant 1	0.18(0.38)	0.24(0.43)	-0.15	0.25(0.43)	0.24(0.42)	-0.03	0.23(0.42)	0.24(0.42)	0.01	0.24(0.42)	0.24(0.42)	0.00
Cohabitant 2	0.77(0.42)	0.74(0.44)	0.06	0.73(0.44)	0.74(0.44)	0.03	0.75(0.44)	0.74(0.44)	-0.01	0.74(0.44)	0.74(0.44)	0.00
Cohabitant 3	0.05(0.23)	0.02(0.14)	0.19	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
Caregiver 1	0.04(0.2)	0.05(0.22)	-0.05	0.06(0.23)	0.05(0.22)	-0.02	0.05(0.21)	0.05(0.22)	0.02	0.05(0.22)	0.05(0.22)	0.00
Caregiver 2	0.88(0.32)	0.87(0.33)	0.02	0.87(0.33)	0.87(0.33)	0.01	0.88(0.32)	0.87(0.33)	-0.03	0.87(0.33)	0.87(0.33)	0.00
Caregiver 3	0.08(0.27)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.01	0.07(0.25)	0.07(0.26)	0.02	0.07(0.26)	0.07(0.26)	0.00
LTC Grade 1	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 2	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 3	0.51(0.5)	0.35(0.48)	0.33	0.36(0.48)	0.36(0.48)	-0.01	0.38(0.48)	0.36(0.48)	-0.03	0.36(0.48)	0.36(0.48)	0.00
LTC Grade 4	0.49(0.5)	0.65(0.48)	-0.33	0.64(0.48)	0.64(0.48)	0.01	0.62(0.48)	0.64(0.48)	0.03	0.64(0.48)	0.64(0.48)	0.00
LTC Grade 5	–	–	–	–	–	–	–	–	–	–	–	–
CCI 0	0.11(0.31)	0.13(0.34)	0.08	0.12(0.33)	0.13(0.33)	0.02	0.12(0.33)	0.13(0.33)	0.01	0.13(0.33)	0.13(0.33)	0.00
CCI 1	0.31(0.46)	0.24(0.43)	-0.17	0.23(0.42)	0.24(0.43)	0.04	0.24(0.43)	0.24(0.43)	0.01	0.24(0.43)	0.24(0.43)	0.00
CCI 2+	0.58(0.49)	0.63(0.48)	0.10	0.65(0.48)	0.63(0.48)	-0.05	0.64(0.48)	0.63(0.48)	-0.01	0.63(0.48)	0.63(0.48)	0.00
Entrance (=2016)	0.32(0.47)	0.29(0.45)	0.05	0.31(0.46)	0.29(0.46)	-0.03	0.3(0.46)	0.29(0.46)	-0.01	0.29(0.46)	0.29(0.46)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	0.03	0.32(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.49)	-0.08	0.37(0.48)	0.38(0.48)	0.01	0.37(0.48)	0.38(0.48)	0.01	0.38(0.48)	0.38(0.48)	0.00
Big city area	0.49(0.5)	0.52(0.5)	-0.06	0.5(0.5)	0.51(0.5)	0.03	0.5(0.5)	0.51(0.5)	0.02	0.51(0.5)	0.51(0.5)	0.00
City area	0.34(0.47)	0.31(0.46)	0.07	0.19(0.39)	0.18(0.38)	-0.02	0.18(0.38)	0.18(0.38)	-0.01	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.17(0.38)	0.18(0.38)	-0.01	0.32(0.47)	0.31(0.46)	-0.02	0.32(0.47)	0.31(0.46)	-0.02	0.31(0.46)	0.31(0.46)	0.00
Treatment 2	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=197,735)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	61(7.14)	58.54(6.67)	-0.36	58.7(6.68)	58.73(6.75)	0.00	58.93(6.72)	58.73(6.75)	-0.03	58.73(6.74)	58.73(6.74)	0.00
ADL	2.83(0.92)	3.05(0.92)	0.24	3.01(0.9)	3.03(0.93)	0.02	2.99(0.9)	3.03(0.93)	0.05	3.03(0.93)	3.03(0.93)	0.00

IADL	2.51(1.53)	2.93(1.5)	0.28	2.86(1.54)	2.9(1.51)	0.02	2.83(1.54)	2.9(1.51)	0.05	2.9(1.51)	2.9(1.51)	0.00
Cognition	4.9(1.84)	5.95(1.98)	-0.55	5.7(1.83)	5.87(2)	-0.09	5.63(1.83)	5.87(2)	-0.12	5.87(1.99)	5.87(1.99)	0.00
Age	83.39(8.54)	81.33(7.92)	-0.25	81.67(7.93)	81.49(7.97)	-0.02	81.79(8.09)	81.49(7.97)	-0.04	81.49(7.99)	81.49(7.99)	0.00
IC provision	27.28(13.74)	24.71(13.19)	-0.19	25.29(12.92)	24.92(13.31)	-0.03	25.42(13)	24.92(13.31)	-0.04	24.91(13.25)	24.91(13.25)	0.00
LH provision	0.2(0.13)	0.21(0.14)	0.10	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.11(0.57)	2.14(0.57)	0.04	2.15(0.57)	2.14(0.57)	-0.02	2.14(0.57)	2.14(0.57)	-0.01	2.14(0.57)	2.14(0.57)	0.00
Outpatient visits	25.44(30.59)	40.38(39.14)	0.43	56.56(73.35)	39.25(38.36)	-0.49	43.8(57.07)	39.36(38.41)	-0.13	39.24(38.76)	39.24(38.77)	0.00
Inpatient days: total	23.76(57.19)	22.79(46.96)	-0.02	22.43(48.23)	22.86(47.83)	0.01	22.71(49.52)	22.85(47.79)	0.00	22.87(47.82)	22.87(47.82)	0.00
Inpatient days: LH	10.45(44.18)	5.49(28.87)	-0.13	5.74(26.99)	5.87(30.64)	0.00	6.02(27.93)	5.86(30.61)	0.00	5.87(30.33)	5.87(30.34)	0.00
2. Binary												
Sex (female=1)	0.64(0.48)	0.66(0.47)	0.04	0.63(0.48)	0.65(0.48)	0.06	0.63(0.48)	0.65(0.48)	0.04	0.66(0.48)	0.66(0.48)	0.00
Medicaid (=1)	0.11(0.32)	0.1(0.3)	-0.04	0.11(0.31)	0.1(0.3)	-0.03	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.21(0.41)	0.3(0.46)	0.21	0.3(0.46)	0.29(0.46)	-0.01	0.28(0.45)	0.29(0.46)	0.02	0.29(0.46)	0.29(0.46)	0.00
Dementia (=1)	0.26(0.44)	0.09(0.28)	-0.47	0.11(0.32)	0.1(0.3)	-0.04	0.11(0.32)	0.1(0.3)	-0.03	0.1(0.3)	0.1(0.3)	0.00
Diabetes (=1)	0.03(0.17)	0.04(0.19)	0.03	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.18)	0.02(0.15)	-0.05	0.02(0.15)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.28(0.45)	0.23(0.42)	-0.10	0.25(0.43)	0.24(0.42)	-0.03	0.24(0.43)	0.24(0.43)	-0.01	0.24(0.42)	0.24(0.42)	0.00
Income group 2	0.12(0.32)	0.09(0.28)	-0.09	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	-0.01	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.35)	0.12(0.32)	-0.06	0.12(0.33)	0.12(0.33)	0.00	0.12(0.33)	0.12(0.33)	-0.01	0.12(0.33)	0.12(0.33)	0.00
Income group 4	0.18(0.38)	0.18(0.38)	0.00	0.17(0.38)	0.18(0.38)	0.02	0.17(0.38)	0.18(0.38)	0.01	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.29(0.45)	0.38(0.49)	0.20	0.37(0.48)	0.37(0.48)	0.02	0.37(0.48)	0.37(0.48)	0.01	0.37(0.48)	0.37(0.48)	0.00
Cohabitant 1	0.18(0.38)	0.24(0.43)	0.15	0.24(0.43)	0.23(0.42)	-0.02	0.23(0.42)	0.23(0.42)	0.02	0.23(0.42)	0.23(0.42)	0.00
Cohabitant 2	0.77(0.42)	0.74(0.44)	-0.06	0.74(0.44)	0.74(0.44)	0.02	0.75(0.43)	0.74(0.44)	-0.01	0.74(0.44)	0.74(0.44)	0.00
Cohabitant 3	0.05(0.23)	0.02(0.14)	-0.19	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
Caregiver 1	0.04(0.2)	0.05(0.22)	0.05	0.05(0.23)	0.05(0.22)	-0.01	0.05(0.21)	0.05(0.22)	0.02	0.05(0.22)	0.05(0.22)	0.00

Caregiver 2	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00	0.89(0.32)	0.88(0.33)	-0.03	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.08(0.27)	0.07(0.26)	-0.02	0.07(0.25)	0.07(0.26)	0.01	0.07(0.25)	0.07(0.26)	0.02	0.07(0.26)	0.07(0.26)	0.00
LTC Grade 1	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 2	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 3	0.51(0.5)	0.35(0.5)	-0.32	0.37(0.48)	0.36(0.48)	0.00	0.38(0.48)	0.36(0.48)	-0.03	0.36(0.48)	0.36(0.48)	0.00
LTC Grade 4	0.49(0.5)	0.65(0.48)	0.32	0.63(0.48)	0.64(0.48)	0.00	0.62(0.48)	0.64(0.48)	0.03	0.64(0.48)	0.64(0.48)	0.00
LTC Grade 5	–	–	–	–	–	–	–	–	–	–	–	–
CCI 0	0.11(0.31)	0.13(0.34)	0.06	0.12(0.33)	0.13(0.33)	0.01	0.13(0.33)	0.13(0.33)	0.00	0.13(0.33)	0.13(0.33)	0.00
CCI 1	0.30(0.46)	0.24(0.43)	-0.14	0.24(0.43)	0.25(0.43)	0.01	0.24(0.43)	0.25(0.43)	0.00	0.25(0.43)	0.25(0.43)	0.00
CCI 2+	0.59(0.49)	0.63(0.48)	0.09	0.63(0.48)	0.63(0.48)	-0.02	0.63(0.48)	0.63(0.48)	0.00	0.63(0.48)	0.63(0.48)	0.00
Entrance (=2016)	0.32(0.47)	0.29(0.46)	-0.05	0.31(0.46)	0.3(0.46)	-0.03	0.3(0.46)	0.3(0.46)	-0.01	0.3(0.46)	0.3(0.46)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	-0.03	0.32(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.48)	0.08	0.37(0.48)	0.37(0.48)	0.01	0.37(0.48)	0.37(0.48)	0.01	0.37(0.48)	0.37(0.48)	0.00
Big city area	0.49(0.5)	0.51(0.5)	0.05	0.49(0.5)	0.51(0.5)	0.03	0.5(0.5)	0.51(0.5)	0.02	0.51(0.5)	0.51(0.5)	0.00
City area	0.17(0.38)	0.18(0.38)	0.01	0.19(0.39)	0.18(0.38)	-0.02	0.18(0.38)	0.18(0.38)	-0.01	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.34(0.47)	0.31(0.46)	-0.06	0.32(0.47)	0.31(0.46)	-0.02	0.32(0.47)	0.31(0.46)	-0.02	0.31(0.46)	0.31(0.46)	0.00
Treatment 3	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=197,735)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	60.3(7.06)	58.48(6.65)	0.26	58.8(6.69)	58.73(6.76)	-0.01	58.88(6.72)	58.73(6.75)	-0.02	58.73(6.74)	58.73(6.74)	0.00
ADL	2.88(0.91)	3.06(0.92)	-0.19	3(0.91)	3.03(0.93)	0.03	2.99(0.91)	3.03(0.93)	0.04	3.03(0.93)	3.03(0.93)	0.00
IADL	2.6(1.53)	2.95(1.5)	-0.23	2.86(1.53)	2.9(1.51)	0.03	2.84(1.53)	2.9(1.51)	0.04	2.9(1.51)	2.9(1.51)	0.00
Cognition	5.01(1.84)	6(1.97)	0.52	5.73(1.86)	5.86(2.01)	-0.07	5.68(1.85)	5.87(2.01)	-0.10	5.87(1.99)	5.87(1.99)	0.00
Age	83.35(8.11)	81.19(7.93)	0.27	81.72(7.89)	81.49(7.98)	-0.03	81.84(7.92)	81.48(7.98)	-0.04	81.49(7.99)	81.49(7.99)	0.00
IC provision	27.29(13.58)	24.54(13.16)	0.21	25.32(12.86)	24.93(13.37)	-0.03	25.4(12.9)	24.93(13.37)	-0.04	24.91(13.25)	24.91(13.25)	0.00
LH provision	0.2(0.13)	0.21(0.14)	-0.11	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.02	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.12(0.57)	2.14(0.57)	-0.02	2.14(0.57)	2.14(0.57)	-0.01	2.14(0.57)	2.14(0.57)	-0.01	2.14(0.57)	2.14(0.57)	0.00

Outpatient visits	27.95(31.76)	41(39.45)	-0.36	45.9(57.16)	39.26(38.13)	-0.19	40.98(50.01)	39.41(38.22)	-0.04	39.24(38.76)	39.24(38.76)	0.00
Inpatient days: total	19.79(49.1)	23.34(47.6)	-0.07	23.23(51.21)	22.84(47.63)	-0.01	22.47(50.16)	22.9(47.71)	0.01	22.87(47.82)	22.87(47.82)	0.00
Inpatient days: LH	7.65(36.75)	5.59(29.2)	0.06	5.61(27.8)	5.85(30.53)	0.01	5.63(27.98)	5.87(30.59)	0.01	5.87(30.33)	5.87(30.33)	0.00
2. Binary												
Sex (female=1)	0.65(0.48)	0.66(0.47)	-0.02	0.64(0.48)	0.65(0.48)	0.03	0.64(0.48)	0.65(0.48)	0.02	0.66(0.48)	0.66(0.48)	0.00
Medicaid (=1)	0.09(0.29)	0.1(0.31)	-0.03	0.1(0.31)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.01	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.21(0.41)	0.31(0.46)	-0.22	0.29(0.45)	0.29(0.46)	0.02	0.28(0.45)	0.29(0.46)	0.03	0.29(0.46)	0.29(0.46)	0.00
Dementia (=1)	0.23(0.42)	0.08(0.27)	0.42	0.11(0.31)	0.1(0.3)	-0.02	0.11(0.31)	0.1(0.3)	-0.02	0.1(0.3)	0.1(0.3)	0.00
Diabetes (=1)	0.03(0.18)	0.04(0.19)	-0.02	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00	0.04(0.19)	0.04(0.19)	0.00
Hypertension (=1)	0.03(0.17)	0.02(0.15)	0.05	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.26(0.44)	0.23(0.42)	0.05	0.24(0.43)	0.24(0.42)	-0.01	0.24(0.42)	0.24(0.43)	0.00	0.24(0.42)	0.24(0.42)	0.00
Income group 2	0.11(0.31)	0.09(0.28)	0.08	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.14(0.34)	0.12(0.32)	0.05	0.12(0.33)	0.12(0.33)	-0.01	0.12(0.33)	0.12(0.33)	-0.01	0.12(0.33)	0.12(0.33)	0.00
Income group 4	0.18(0.38)	0.18(0.38)	0.01	0.17(0.38)	0.18(0.38)	0.01	0.17(0.38)	0.18(0.38)	0.00	0.18(0.38)	0.18(0.38)	0.00
Income group 5	0.32(0.47)	0.38(0.49)	-0.14	0.37(0.48)	0.37(0.48)	0.00	0.37(0.48)	0.37(0.48)	0.00	0.37(0.48)	0.37(0.48)	0.00
Cohabitant 1	0.19(0.39)	0.24(0.43)	-0.13	0.23(0.42)	0.23(0.42)	0.00	0.23(0.42)	0.23(0.42)	0.01	0.23(0.42)	0.23(0.42)	0.00
Cohabitant 2	0.77(0.42)	0.74(0.44)	0.08	0.74(0.44)	0.74(0.44)	0.00	0.75(0.43)	0.74(0.44)	-0.01	0.74(0.44)	0.74(0.44)	0.00
Cohabitant 3	0.04(0.19)	0.02(0.14)	0.12	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00	0.02(0.15)	0.02(0.15)	0.00
Caregiver 1	0.05(0.21)	0.05(0.22)	-0.04	0.05(0.22)	0.05(0.22)	0.00	0.05(0.22)	0.05(0.22)	0.01	0.05(0.22)	0.05(0.22)	0.00
Caregiver 2	0.89(0.31)	0.87(0.33)	0.05	0.88(0.33)	0.88(0.33)	0.00	0.88(0.32)	0.88(0.33)	-0.01	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.06(0.24)	0.07(0.26)	-0.04	0.07(0.26)	0.07(0.26)	0.00	0.07(0.25)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.00
LTC Grade 1	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 2	–	–	–	–	–	–	–	–	–	–	–	–
LTC Grade 3	0.46(0.5)	0.35(0.48)	0.24	0.37(0.48)	0.36(0.48)	-0.01	0.37(0.48)	0.36(0.48)	-0.02	0.36(0.48)	0.36(0.48)	0.00
LTC Grade 4	0.54(0.5)	0.65(0.48)	-0.24	0.63(0.48)	0.64(0.48)	0.01	0.63(0.48)	0.64(0.48)	0.02	0.64(0.48)	0.64(0.48)	0.00

LTC Grade 5	–	–	–	–	–	–	–	–	–	–	–	–
CCI 0	0.41(0.49)	0.38(0.49)	0.05	0.38(0.48)	0.38(0.49)	0.01	0.38(0.49)	0.38(0.49)	0.01	0.38(0.49)	0.38(0.49)	0.00
CCI 1	0.35(0.48)	0.34(0.47)	0.02	0.35(0.48)	0.34(0.48)	0.00	0.35(0.48)	0.34(0.48)	0.00	0.34(0.48)	0.34(0.48)	0.00
CCI 2+	0.24(0.43)	0.28(0.45)	-0.08	0.28(0.45)	0.27(0.44)	-0.01	0.27(0.45)	0.27(0.44)	0.00	0.27(0.44)	0.27(0.44)	0.00
Entrance (=2016)	0.32(0.47)	0.29(0.45)	0.06	0.3(0.46)	0.3(0.46)	-0.01	0.3(0.46)	0.3(0.46)	-0.01	0.3(0.46)	0.3(0.46)	0.00
Entrance (=2017)	0.34(0.47)	0.33(0.47)	0.02	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00
Entrance (=2018)	0.34(0.47)	0.38(0.49)	-0.07	0.37(0.48)	0.37(0.48)	0.01	0.37(0.48)	0.37(0.48)	0.01	0.37(0.48)	0.37(0.48)	0.00
Big city area	0.48(0.5)	0.52(0.5)	-0.08	0.5(0.5)	0.51(0.5)	0.02	0.5(0.5)	0.51(0.5)	0.02	0.51(0.5)	0.51(0.5)	0.00
City area	0.34(0.48)	0.31(0.46)	0.08	0.18(0.39)	0.18(0.38)	-0.02	0.18(0.39)	0.18(0.38)	-0.01	0.18(0.38)	0.18(0.38)	0.00
Rural area	0.18(0.38)	0.18(0.38)	0.00	0.32(0.47)	0.31(0.46)	-0.01	0.32(0.47)	0.31(0.46)	-0.01	0.31(0.46)	0.31(0.46)	0.00

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow-up period) were treated as RC group

* IPTW: Inverse probability of treatment weighting; CBPS: Covariate balancing propensity score; ADL: Activities of daily living; IADL: Instrumental activities of daily living; LH: Long-term care hospital; CCI: Charlson comorbidity index

* Mean (standard error) was reported for continuous variables and proportion (standard error) was reported for binary and categorical variables

[Appendix 3.2] Balance of baseline covariates before and after weighting: (3) LTC eligibility grade 5 subgroup

Treatment 1	No weights			IPTW (logistic model)			IPTW (CBPS)			Entropy balancing weights		
(n=39,309)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	47.72(1.91)	47.6(1.88)	-0.06	47.58(1.89)	47.6(1.88)	0.01	47.61(1.89)	47.6(1.88)	0.00	47.6(1.88)	47.6(1.88)	0.00
ADL	4.42(0.56)	4.38(0.56)	-0.06	4.38(0.56)	4.39(0.56)	0.02	4.38(0.56)	4.39(0.56)	0.00	4.39(0.56)	4.39(0.56)	0.00
IADL	4.19(1.39)	4.3(1.32)	0.08	4.27(1.36)	4.29(1.33)	0.01	4.26(1.36)	4.29(1.33)	0.02	4.29(1.33)	4.29(1.33)	0.00
Cognition	5.87(1.58)	6.18(1.57)	-0.20	6.19(1.57)	6.17(1.57)	0.01	6.17(1.56)	6.17(1.57)	0.00	6.17(1.57)	6.17(1.57)	0.00
Age	82.68(6.87)	81.48(6.77)	-0.18	81.32(7.13)	81.53(6.78)	0.03	81.4(7.11)	81.53(6.78)	0.02	81.53(6.78)	81.53(6.78)	0.00
IC provision	28.94(15.22)	25.97(13.6)	-0.21	26.2(13.85)	26.12(13.71)	-0.01	26.2(13.89)	26.12(13.7)	-0.01	26.11(13.7)	26.11(13.7)	0.00
LH provision	0.2(0.14)	0.21(0.14)	0.09	0.22(0.16)	0.21(0.14)	-0.03	0.22(0.16)	0.21(0.14)	-0.01	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.17(0.58)	2.22(0.56)	0.09	2.23(0.59)	2.22(0.56)	-0.01	2.22(0.59)	2.22(0.56)	0.00	2.22(0.56)	2.22(0.56)	0.00
Outpatient visits	28.72(33.02)	36.49(35.9)	0.23	38.96(47.51)	36.13(35.55)	-0.08	36.62(44.07)	36.17(35.58)	-0.01	36.13(35.8)	36.13(35.82)	0.00
Inpatient days: total	11.94(34.35)	10.9(32.04)	-0.03	11.65(28.65)	10.95(32.41)	-0.02	11.58(28.99)	10.94(32.34)	-0.02	10.95(32.15)	10.95(32.17)	0.00
Inpatient days: LH	4.91(25.67)	3.43(23.49)	-0.06	4.11(18.99)	3.5(23.9)	-0.02	4.19(19.75)	3.48(23.81)	-0.03	3.5(23.6)	3.5(23.61)	0.00
2. Binary												
Sex (female=1)	0.71(0.45)	0.72(0.45)	0.02	0.71(0.45)	0.72(0.45)	0.01	0.71(0.45)	0.72(0.45)	0.01	0.72(0.45)	0.72(0.45)	0.00
Medicaid (=1)	0.11(0.31)	0.1(0.3)	-0.01	0.1(0.31)	0.1(0.3)	0.00	0.1(0.31)	0.1(0.3)	-0.01	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.16(0.37)	0.2(0.4)	0.11	0.2(0.4)	0.2(0.4)	0.00	0.2(0.4)	0.2(0.4)	0.01	0.2(0.4)	0.2(0.4)	0.00
Dementia (=1)	–	–	–	–	–	–	–	–	–	–	–	–
Diabetes (=1)	0.03(0.17)	0.03(0.17)	0.00	0.02(0.16)	0.03(0.17)	0.02	0.02(0.15)	0.03(0.17)	0.03	0.03(0.17)	0.03(0.17)	0.00
Hypertension (=1)	0.02(0.15)	0.02(0.15)	-0.02	0.02(0.13)	0.02(0.15)	0.03	0.02(0.13)	0.02(0.15)	0.03	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.27(0.44)	0.23(0.42)	-0.08	0.24(0.42)	0.24(0.42)	0.00	0.24(0.42)	0.24(0.42)	0.00	0.24(0.42)	0.24(0.42)	0.00
Income group 2	0.11(0.31)	0.09(0.28)	-0.07	0.09(0.29)	0.09(0.28)	-0.01	0.09(0.29)	0.09(0.28)	-0.02	0.09(0.28)	0.09(0.28)	0.00
Income group 3	0.13(0.33)	0.12(0.32)	-0.03	0.11(0.32)	0.12(0.32)	0.01	0.12(0.32)	0.12(0.32)	0.00	0.12(0.32)	0.12(0.32)	0.00

Income group 4	0.18(0.38)	0.17(0.38)	-0.02	0.16(0.37)	0.17(0.38)	0.02	0.17(0.37)	0.17(0.38)	0.01	0.17(0.38)	0.17(0.38)	0.00
Income group 5	0.32(0.47)	0.39(0.49)	0.16	0.4(0.49)	0.39(0.49)	-0.02	0.39(0.49)	0.39(0.49)	0.00	0.39(0.49)	0.39(0.49)	0.00
Cohabitant 1	0.29(0.45)	0.29(0.46)	0.02	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.46)	0.01	0.29(0.45)	0.29(0.45)	0.00
Cohabitant 2	0.68(0.47)	0.69(0.46)	0.03	0.7(0.46)	0.69(0.46)	-0.01	0.7(0.46)	0.69(0.46)	-0.01	0.69(0.46)	0.69(0.46)	0.00
Cohabitant 3	0.03(0.18)	0.01(0.11)	-0.14	0.01(0.11)	0.01(0.12)	0.01	0.01(0.12)	0.01(0.12)	0.00	0.01(0.12)	0.01(0.12)	0.00
Caregiver 1	0.08(0.27)	0.07(0.26)	-0.01	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.00
Caregiver 2	0.86(0.35)	0.88(0.33)	0.06	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.07(0.25)	0.05(0.21)	-0.08	0.04(0.21)	0.05(0.21)	0.02	0.04(0.21)	0.05(0.21)	0.02	0.05(0.21)	0.05(0.21)	0.00
LTC Grade 1 LTC Grade 2 LTC Grade 3 LTC Grade 4 LTC Grade 5												
CCI 0	0.03(0.17)	0.02(0.14)	-0.07	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00
CCI 1	0.33(0.47)	0.27(0.44)	-0.15	0.28(0.45)	0.27(0.44)	-0.01	0.28(0.45)	0.27(0.44)	-0.01	0.27(0.44)	0.27(0.44)	0.00
CCI 2+	0.64(0.48)	0.71(0.45)	0.17	0.70(0.46)	0.71(0.45)	0.01	0.70(0.46)	0.71(0.45)	0.01	0.71(0.45)	0.71(0.45)	0.00
Entrance (=2016)	0.34(0.47)	0.25(0.44)	-0.19	0.26(0.44)	0.26(0.44)	-0.01	0.26(0.44)	0.26(0.44)	-0.01	0.26(0.44)	0.26(0.44)	0.00
Entrance (=2017)	0.35(0.48)	0.34(0.47)	-0.01	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00
Entrance (=2018)	0.31(0.46)	0.41(0.49)	0.19	0.4(0.49)	0.4(0.49)	0.00	0.4(0.49)	0.4(0.49)	0.01	0.4(0.49)	0.4(0.49)	0.00
Big city area	0.51(0.5)	0.5(0.5)	-0.03	0.51(0.5)	0.5(0.5)	-0.01	0.51(0.5)	0.5(0.5)	-0.02	0.5(0.5)	0.5(0.5)	0.00
City area	0.13(0.34)	0.17(0.38)	0.10	0.17(0.37)	0.17(0.37)	0.00	0.16(0.37)	0.17(0.37)	0.02	0.17(0.37)	0.17(0.37)	0.00
Rural area	0.35(0.48)	0.33(0.47)	-0.05	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00
Treatment 2	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=42,043)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
1. Continuous												
Eligibility score	47.72(1.91)	47.61(1.88)	-0.06	47.59(1.89)	47.61(1.88)	0.01	47.61(1.89)	47.61(1.88)	0.00	47.61(1.88)	47.61(1.88)	0.00
ADL	4.42(0.56)	4.39(0.56)	-0.06	4.38(0.56)	4.39(0.56)	0.01	4.39(0.56)	4.39(0.56)	0.00	4.39(0.56)	4.39(0.56)	0.00

IADL	4.19(1.39)	4.29(1.33)	0.07	4.26(1.36)	4.28(1.33)	0.02	4.25(1.37)	4.28(1.33)	0.02	4.28(1.33)	4.28(1.33)	0.00
Cognition	5.87(1.58)	6.16(1.57)	-0.19	6.17(1.57)	6.15(1.57)	0.01	6.15(1.57)	6.15(1.57)	0.00	6.15(1.57)	6.15(1.58)	0.00
Age	82.68(6.87)	81.54(6.78)	-0.17	81.4(7.11)	81.59(6.79)	0.03	81.46(7.1)	81.59(6.79)	0.02	81.59(6.79)	81.59(6.79)	0.00
IC provision	28.94(15.22)	26.12(13.65)	-0.20	26.38(13.94)	26.25(13.74)	-0.01	26.36(13.97)	26.25(13.74)	-0.01	26.25(13.74)	26.25(13.74)	0.00
LH provision	0.2(0.14)	0.21(0.14)	0.09	0.22(0.16)	0.21(0.14)	-0.03	0.21(0.15)	0.21(0.14)	-0.01	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.17(0.58)	2.22(0.56)	0.09	2.23(0.59)	2.22(0.56)	-0.01	2.22(0.59)	2.22(0.56)	0.00	2.22(0.56)	2.22(0.56)	0.00
Outpatient visits	28.72(33.02)	36.1(35.7)	0.21	38.2(46.49)	35.78(35.38)	-0.07	36.08(43.34)	35.81(35.41)	-0.01	35.78(35.62)	35.78(35.63)	0.00
Inpatient days: total	11.94(34.35)	10.73(31.86)	-0.04	11.49(28.4)	10.79(32.22)	-0.02	11.45(28.79)	10.78(32.16)	-0.02	10.79(31.97)	10.79(31.99)	0.00
Inpatient days: LH	4.91(25.67)	3.39(23.34)	-0.06	4.07(18.96)	3.46(23.73)	-0.02	4.16(19.73)	3.45(23.64)	-0.03	3.46(23.45)	3.46(23.46)	0.00
2. Binary												
Sex (female=1)	0.71(0.45)	0.72(0.45)	0.02	0.71(0.45)	0.72(0.45)	0.01	0.71(0.45)	0.72(0.45)	0.01	0.72(0.45)	0.72(0.45)	0.00
Medicaid (=1)	0.11(0.31)	0.1(0.3)	-0.02	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.16(0.37)	0.2(0.4)	0.11	0.2(0.4)	0.2(0.4)	0.00	0.2(0.4)	0.2(0.4)	0.01	0.2(0.4)	0.2(0.4)	0.00
Dementia (=1)	–	–	–	–	–	–	–	–	–	–	–	–
Diabetes (=1)	0.03(0.17)	0.03(0.17)	0.00	0.03(0.16)	0.03(0.17)	0.02	0.02(0.15)	0.03(0.17)	0.03	0.03(0.17)	0.03(0.17)	0.00
Hypertension (=1)	0.02(0.15)	0.02(0.15)	-0.02	0.02(0.13)	0.02(0.15)	0.03	0.02(0.13)	0.02(0.15)	0.03	0.02(0.15)	0.02(0.15)	0.00
3. Categorical												
Income group 1	0.27(0.44)	0.23(0.42)	-0.08	0.24(0.42)	0.24(0.42)	0.00	0.24(0.42)	0.24(0.42)	0.00	0.24(0.42)	0.24(0.42)	0.00
Income group 2	0.11(0.31)	0.09(0.28)	-0.06	0.09(0.29)	0.09(0.29)	-0.01	0.09(0.29)	0.09(0.28)	-0.02	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.13(0.33)	0.12(0.32)	-0.03	0.12(0.32)	0.12(0.32)	0.01	0.12(0.32)	0.12(0.32)	0.00	0.12(0.32)	0.12(0.32)	0.00
Income group 4	0.18(0.38)	0.17(0.38)	-0.02	0.16(0.37)	0.17(0.38)	0.02	0.17(0.37)	0.17(0.38)	0.01	0.17(0.38)	0.17(0.38)	0.00
Income group 5	0.32(0.47)	0.39(0.49)	0.15	0.39(0.49)	0.39(0.49)	-0.01	0.39(0.49)	0.39(0.49)	0.00	0.39(0.49)	0.39(0.49)	0.00
Cohabitant 1	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.45)	0.00
Cohabitant 2	0.68(0.47)	0.69(0.46)	0.03	0.7(0.46)	0.69(0.46)	-0.01	0.7(0.46)	0.69(0.46)	-0.01	0.69(0.46)	0.69(0.46)	0.00
Cohabitant 3	0.03(0.18)	0.01(0.12)	-0.14	0.01(0.12)	0.01(0.12)	0.01	0.01(0.12)	0.01(0.12)	0.00	0.01(0.12)	0.01(0.12)	0.00
Caregiver 1	0.08(0.27)	0.07(0.26)	-0.01	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.00

Caregiver 2	0.86(0.35)	0.88(0.33)	0.06	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.32)	0.88(0.33)	-0.02	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.07(0.25)	0.05(0.21)	-0.08	0.05(0.21)	0.05(0.21)	0.01	0.05(0.21)	0.05(0.21)	0.01	0.05(0.21)	0.05(0.21)	0.00
LTC Grade 1												
LTC Grade 2												
LTC Grade 3												
LTC Grade 4												
LTC Grade 5												
CCI 0	0.02(0.15)	0.02(0.14)	-0.02	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00
CCI 1	0.33(0.47)	0.27(0.44)	-0.13	0.28(0.45)	0.27(0.44)	-0.01	0.28(0.45)	0.27(0.44)	-0.01	0.27(0.44)	0.27(0.44)	0.00
CCI 2+	0.65(0.48)	0.71(0.45)	0.13	0.70(0.46)	0.71(0.45)	0.01	0.70(0.46)	0.71(0.45)	0.01	0.71(0.45)	0.71(0.45)	0.00
Entrance (=2016)	0.34(0.47)	0.25(0.44)	-0.19	0.26(0.44)	0.26(0.44)	-0.01	0.26(0.44)	0.26(0.44)	-0.01	0.26(0.44)	0.26(0.44)	0.00
Entrance (=2017)	0.35(0.48)	0.34(0.47)	-0.01	0.34(0.48)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00
Entrance (=2018)	0.31(0.46)	0.4(0.49)	0.19	0.39(0.49)	0.4(0.49)	0.01	0.39(0.49)	0.4(0.49)	0.01	0.4(0.49)	0.4(0.49)	0.00
Big city area	0.51(0.5)	0.5(0.5)	-0.03	0.5(0.5)	0.5(0.5)	-0.01	0.51(0.5)	0.5(0.5)	-0.02	0.5(0.5)	0.5(0.5)	0.00
City area	0.13(0.34)	0.17(0.38)	0.10	0.17(0.37)	0.17(0.37)	0.01	0.16(0.37)	0.17(0.37)	0.02	0.17(0.37)	0.17(0.37)	0.00
Rural area	0.35(0.48)	0.33(0.47)	-0.05	0.33(0.47)	0.33(0.47)	0.01	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00
Treatment 3	**No weights**			**IPTW (logistic model)**			**IPTW (CBPS)**			**Entropy balancing weights**		
(n=42,043)	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D	RC group	HC group	S.D
5 Continuous												
Eligibility score	47.73(1.9)	47.6(1.88)	-0.07	47.62(1.88)	47.61(1.88)	-0.01	47.63(1.88)	47.61(1.88)	-0.01	47.61(1.88)	47.61(1.88)	0.00
ADL	4.4(0.55)	4.38(0.56)	-0.04	4.38(0.56)	4.39(0.56)	0.01	4.38(0.56)	4.39(0.56)	0.01	4.39(0.56)	4.39(0.56)	0.00
IADL	4.19(1.37)	4.3(1.32)	0.08	4.27(1.33)	4.28(1.33)	0.01	4.27(1.33)	4.28(1.33)	0.01	4.28(1.33)	4.28(1.33)	0.00
Cognition	5.88(1.56)	6.18(1.57)	-0.19	6.16(1.56)	6.15(1.58)	0.01	6.15(1.56)	6.15(1.58)	0.00	6.15(1.57)	6.15(1.57)	0.00
Age	82.5(6.87)	81.48(6.77)	-0.15	81.6(6.84)	81.59(6.79)	0.00	81.61(6.84)	81.59(6.79)	0.00	81.59(6.79)	81.59(6.79)	0.00
IC provision	28.47(14.61)	25.97(13.6)	-0.18	26.32(13.47)	26.25(13.78)	-0.01	26.34(13.5)	26.25(13.78)	-0.01	26.25(13.74)	26.25(13.74)	0.00
LH provision	0.2(0.13)	0.21(0.14)	0.07	0.21(0.14)	0.21(0.14)	0.00	0.21(0.14)	0.21(0.14)	0.00	0.21(0.14)	0.21(0.14)	0.00
HC provision	2.2(0.56)	2.22(0.56)	0.05	2.23(0.57)	2.22(0.56)	-0.01	2.23(0.57)	2.22(0.56)	-0.01	2.22(0.56)	2.22(0.56)	0.00

Outpatient visits	29.94(32.68)	36.49(35.9)	0.19	37.24(44.44)	35.79(35.18)	-0.04	35.94(41.87)	35.85(35.25)	0.00	35.78(35.62)	35.78(35.62)	0.00
Inpatient days: total	9.83(31.4)	10.9(32.04)	0.03	10.84(31.66)	10.78(32.05)	0.00	10.69(31.35)	10.8(32.08)	0.00	10.79(31.97)	10.79(31.98)	0.00
Inpatient days: LH	3.71(23.07)	3.43(23.49)	-0.01	3.46(20.45)	3.46(23.75)	0.00	3.42(20.36)	3.46(23.77)	0.00	3.46(23.45)	3.46(23.45)	0.00
6 Binary												
Sex (female=1)	0.7(0.46)	0.72(0.45)	0.04	0.71(0.45)	0.72(0.45)	0.01	0.71(0.45)	0.72(0.45)	0.01	0.72(0.45)	0.72(0.45)	0.00
Medicaid (=1)	0.09(0.28)	0.1(0.3)	0.06	0.1(0.3)	0.1(0.3)	0.01	0.1(0.3)	0.1(0.3)	0.01	0.1(0.3)	0.1(0.3)	0.00
Disability (=1)	0.17(0.38)	0.2(0.4)	0.08	0.2(0.4)	0.2(0.4)	0.00	0.2(0.4)	0.2(0.4)	0.01	0.2(0.4)	0.2(0.4)	0.00
Dementia (=1)	–	–	–	–	–	–	–	–	–	–	–	–
Diabetes (=1)	0.03(0.18)	0.03(0.17)	-0.02	0.03(0.16)	0.03(0.17)	0.01	0.03(0.16)	0.03(0.17)	0.01	0.03(0.17)	0.03(0.17)	0.00
Hypertension (=1)	0.03(0.16)	0.02(0.15)	-0.03	0.02(0.14)	0.02(0.15)	0.01	0.02(0.14)	0.02(0.15)	0.01	0.02(0.15)	0.02(0.15)	0.00
7 Categorical												
Income group 1	0.24(0.43)	0.23(0.42)	-0.02	0.23(0.42)	0.24(0.42)	0.01	0.23(0.42)	0.24(0.42)	0.01	0.24(0.42)	0.24(0.42)	0.00
Income group 2	0.11(0.31)	0.09(0.28)	-0.07	0.09(0.28)	0.09(0.29)	0.01	0.09(0.28)	0.09(0.28)	0.00	0.09(0.29)	0.09(0.29)	0.00
Income group 3	0.13(0.33)	0.12(0.32)	-0.03	0.12(0.32)	0.12(0.32)	0.00	0.12(0.32)	0.12(0.32)	0.00	0.12(0.32)	0.12(0.32)	0.00
Income group 4	0.18(0.39)	0.17(0.38)	-0.04	0.17(0.37)	0.17(0.38)	0.01	0.17(0.37)	0.17(0.38)	0.01	0.17(0.38)	0.17(0.38)	0.00
Income group 5	0.34(0.47)	0.39(0.49)	0.11	0.39(0.49)	0.39(0.49)	-0.01	0.39(0.49)	0.39(0.49)	-0.01	0.39(0.49)	0.39(0.49)	0.00
Cohabitant 1	0.28(0.45)	0.29(0.46)	0.03	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.45)	0.01	0.29(0.45)	0.29(0.45)	0.00
Cohabitant 2	0.7(0.46)	0.69(0.46)	0.00	0.7(0.46)	0.69(0.46)	-0.01	0.7(0.46)	0.69(0.46)	-0.01	0.69(0.46)	0.69(0.46)	0.00
Cohabitant 3	0.03(0.16)	0.01(0.11)	-0.09	0.01(0.12)	0.01(0.12)	0.00	0.01(0.12)	0.01(0.12)	0.00	0.01(0.12)	0.01(0.12)	0.00
Caregiver 1	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.00	0.07(0.26)	0.07(0.26)	0.01	0.07(0.26)	0.07(0.26)	0.00
Caregiver 2	0.87(0.33)	0.88(0.33)	0.01	0.88(0.32)	0.88(0.33)	-0.01	0.88(0.32)	0.88(0.33)	-0.01	0.88(0.33)	0.88(0.33)	0.00
Caregiver 3	0.05(0.23)	0.05(0.21)	-0.03	0.05(0.21)	0.05(0.21)	0.01	0.05(0.21)	0.05(0.21)	0.01	0.05(0.21)	0.05(0.21)	0.00
LTC Grade 1												
LTC Grade 2												
LTC Grade 3												
LTC Grade 4												
LTC Grade 5												

CCI 0	0.03(0.17)	0.02(0.14)	-0.07	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00	0.02(0.14)	0.02(0.14)	0.00
CCI 1	0.33(0.47)	0.27(0.44)	-0.14	0.28(0.45)	0.27(0.44)	-0.01	0.28(0.45)	0.27(0.44)	-0.01	0.27(0.44)	0.27(0.44)	0.00
CCI 2+	0.64(0.48)	0.71(0.45)	0.16	0.70(0.46)	0.71(0.45)	0.01	0.70(0.46)	0.71(0.45)	0.01	0.71(0.45)	0.71(0.45)	0.00
Entrance (=2016)	0.3(0.46)	0.25(0.44)	-0.09	0.26(0.44)	0.26(0.44)	0.00	0.26(0.44)	0.26(0.44)	0.00	0.26(0.44)	0.26(0.44)	0.00
Entrance (=2017)	0.37(0.48)	0.34(0.47)	-0.07	0.34(0.48)	0.34(0.47)	0.00	0.34(0.48)	0.34(0.47)	0.00	0.34(0.47)	0.34(0.47)	0.00
Entrance (=2018)	0.33(0.47)	0.41(0.49)	0.16	0.4(0.49)	0.4(0.49)	0.00	0.4(0.49)	0.4(0.49)	0.00	0.4(0.49)	0.4(0.49)	0.00
Big city area	0.5(0.5)	0.5(0.5)	0.00	0.5(0.5)	0.5(0.5)	0.00	0.5(0.5)	0.5(0.5)	0.00	0.5(0.5)	0.5(0.5)	0.00
City area	0.15(0.36)	0.17(0.38)	0.05	0.17(0.38)	0.17(0.37)	0.00	0.17(0.37)	0.17(0.37)	0.00	0.17(0.37)	0.17(0.37)	0.00
Rural area	0.35(0.48)	0.33(0.47)	-0.04	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00	0.33(0.47)	0.33(0.47)	0.00

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow-up period) were treated as RC group

* IPTW: Inverse probability of treatment weighting; CBPS: Covariate balancing propensity score; ADL: Activities of daily living; IADL: Instrumental activities of daily living; LH: Long-term care hospital; CCI: Charlson comorbidity index

* Mean (standard error) was reported for continuous variables and proportion (standard error) was reported for binary and categorical variables

[Appendix 4.1] Saturated model for effect modification of initial health status on health, weighted regression results

	Death (=1)			ADL			IADL			Cognition		
	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3
Intercept	0.36(0.00)**	0.36(0.00)**	0.36(0.00)**	0.74(0.01)**	0.75(0.01)**	0.74(0.01)**	1.01(0.02)**	1.02(0.02)**	1.01(0.02)**	2.94(0.03)**	2.96(0.03)**	2.91(0.02)**
IC	0.03(0.01)**	0.03(0.01)**	−0.02(0.01)**	−0.04(0.02)*	−0.05(0.02)*	−0.01(0.02)	−0.05(0.02)*	−0.06(0.02)**	0.01(0.02)	−0.03(0.04)	−0.07(0.04)+	0.17(0.04)**
IC*severity2	0.03(0.01)**	0.02(0.01)**	0.06(0.01)**	−0.49(0.01)**	−0.44(0.02)**	−0.56(0.02)**	−0.52(0.02)**	−0.47(0.02)**	−0.56(0.02)**	−0.87(0.04)**	−0.78(0.04)**	−0.96(0.04)**
IC*severity3	0.03(0.01)**	0.02(0.01)**	0.06(0.01)**	−0.88(0.01)**	−0.81(0.02)**	−0.89(0.02)**	−0.91(0.03)**	−0.83(0.03)**	−0.93(0.03)**	−0.75(0.05)**	−0.66(0.04)**	−0.89(0.04)**
Severity 2	−0.23(0.00)**	−0.22(0.00)**	−0.23(0.00)**	1.81(0.01)**	1.75(0.01)**	1.80(0.01)**	1.53(0.02)**	1.47(0.02)**	1.52(0.02)**	2.15(0.03)**	2.06(0.03)**	2.15(0.03)**
Severity 3	−0.31(0.00)**	−0.30(0.00)**	−0.31(0.00)**	2.83(0.02)**	2.75(0.02)**	2.82(0.02)**	2.63(0.02)**	2.55(0.02)**	2.63(0.02)**	2.50(0.03)**	2.41(0.03)**	2.51(0.03)**

* Treat variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Severest group (grade 1−2) was used as a reference value (=1). Severity 2: grade 3−4; Severity 3: grade 5.

* Treat 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treat 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treat 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* All results adjusting baseline covariates by applying weighted regression adopting entropy balancing weight

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.2] Effect of LTC place on health, using IPTW derived from logistic regression and CBPS

		IPTW, logistic regression				IPTW, CBPS			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 1	Death	0.066(0.006)**	0.021(0.01)*	0.073(0.012)**	0.058(0.009)**	0.061(0.004)**	0.023(0.01)*	0.065(0.006)**	0.057(0.009)**
	ADL	-0.573(0.021)**	-0.053(0.021)*	-0.564(0.033)**	-0.918(0.041)**	-0.568(0.016)**	-0.055(0.021)**	-0.557(0.019)**	-0.92(0.039)**
	IADL	-0.617(0.024)**	-0.07(0.025)**	-0.615(0.035)**	-0.994(0.049)**	-0.616(0.018)**	-0.077(0.023)**	-0.608(0.021)**	-0.996(0.047)**
	Cognition	-0.898(0.04)**	-0.176(0.065)**	-0.981(0.069)**	-0.914(0.058)**	-0.907(0.028)**	-0.207(0.061)**	-0.985(0.037)**	-0.926(0.056)**
Treatment 2	Death	0.064(0.006)**	0.029(0.01)**	0.069(0.01)**	0.055(0.009)**	0.059(0.004)**	0.03(0.01)**	0.063(0.005)**	0.054(0.009)**
	ADL	-0.534(0.019)**	-0.058(0.021)**	-0.521(0.028)**	-0.854(0.04)**	-0.53(0.015)**	-0.06(0.02)**	-0.517(0.018)**	-0.855(0.039)**
	IADL	-0.58(0.022)**	-0.079(0.024)**	-0.573(0.031)**	-0.931(0.047)**	-0.579(0.018)**	-0.086(0.022)**	-0.569(0.02)**	-0.933(0.046)**
	Cognition	-0.858(0.036)**	-0.21(0.062)**	-0.928(0.058)**	-0.861(0.057)**	-0.865(0.027)**	-0.238(0.059)**	-0.935(0.035)**	-0.872(0.055)**
Treatment 3	Death	0.041(0.003)**	-0.016(0.008)+	0.044(0.003)**	0.046(0.005)**	0.039(0.003)**	-0.013(0.008)	0.044(0.003)**	0.045(0.005)**
	ADL	-0.583(0.011)**	-0.025(0.018)	-0.57(0.012)**	-0.923(0.023)**	-0.584(0.01)**	-0.026(0.018)	-0.576(0.011)**	-0.922(0.022)**
	IADL	-0.579(0.012)**	-0.018(0.019)	-0.564(0.014)**	-0.955(0.028)**	-0.587(0.011)**	-0.026(0.019)	-0.576(0.013)**	-0.954(0.028)**
	Cognition	-0.761(0.02)**	0.01(0.053)	-0.807(0.024)**	-0.848(0.034)**	-0.786(0.017)**	-0.022(0.051)	-0.843(0.021)**	-0.852(0.033)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* IPTW: inverse probability of treatment weighting; CBPS: covariate balance propensity score; ADL: activities of daily living; IADL: instrumental activities of daily living

* Reported values are average treatment effect(standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.3] Effect of LTC place on health, using different strategy defining treatment

		Without adjustment				Adjustment of covariates using EB weighting			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 4	Death	0.093(0.003)**	0.011(0.008)	0.068(0.003)**	0.055(0.007)**	0.049(0.004)**	0.022(0.01)*	0.051(0.005)**	0.053(0.009)**
	ADL	-0.835(0.01)**	0.009(0.017)	-0.618(0.012)**	-0.832(0.033)**	-0.488(0.015)**	-0.034(0.021)	-0.463(0.017)**	-0.84(0.04)**
	IADL	-0.925(0.011)**	-0.093(0.018)**	-0.746(0.013)**	-0.961(0.039)**	-0.519(0.017)**	-0.058(0.022)**	-0.489(0.02)**	-0.893(0.048)**
	Cognition	-1.46(0.018)**	-0.42(0.045)**	-1.381(0.021)**	-0.968(0.045)**	-0.731(0.027)**	-0.148(0.06)*	-0.765(0.034)**	-0.845(0.057)**
Treatment 5	Death	-0.002(0.002)	-0.079(0.007)**	-0.017(0.002)**	-0.013(0.004)**	0.022(0.004)**	-0.028(0.009)**	0.023(0.004)**	0.041(0.009)**
	ADL	-0.669(0.008)**	0.099(0.016)**	-0.518(0.009)**	-0.881(0.021)**	-0.487(0.014)**	0.016(0.021)	-0.456(0.017)**	-0.909(0.037)**
	IADL	-0.746(0.009)**	0.028(0.017)	-0.627(0.011)**	-0.959(0.026)**	-0.522(0.017)**	0.003(0.022)	-0.489(0.019)**	-0.967(0.045)**
	Cognition	-1.121(0.014)**	-0.082(0.043)+	-1.095(0.016)**	-0.947(0.03)**	-0.711(0.026)**	0.007(0.06)	-0.737(0.033)**	-0.925(0.054)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 4: Intention to treat (ITT) approach. Treatment variable assigned according to first service utilized.

* Treatment 5: Operational definition approach. Switch users (used both services within follow−up period) who utilized RC more than half of the survival time were treated as RC user.

* EB: Entropy balancing; ADL: activities of daily living; IADL: instrumental activities of daily living

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.4] Effect of LTC place on health, sensitivity analysis in treatment of samples with missing values

		Positive analysis				Negative analysis			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 1	ADL	-0.558(0.015)**	-0.053(0.022)*	-0.53(0.018)**	-0.94(0.041)**	-0.491(0.016)**	-0.044(0.022)*	-0.464(0.018)**	-0.843(0.042)**
	IADL	-0.586(0.018)**	-0.078(0.024)**	-0.554(0.021)**	-0.983(0.05)**	-0.521(0.018)**	-0.063(0.024)**	-0.491(0.021)**	-0.891(0.05)**
	Cognition	-0.778(0.029)**	-0.222(0.065)**	-0.805(0.037)**	-0.882(0.059)**	-0.695(0.029)**	-0.156(0.065)*	-0.721(0.037)**	-0.796(0.061)**
Treatment 2	ADL	-0.52(0.015)**	-0.059(0.021)**	-0.492(0.017)**	-0.876(0.041)**	-0.458(0.015)**	-0.052(0.021)*	-0.432(0.018)**	-0.786(0.041)**
	IADL	-0.551(0.018)**	-0.087(0.023)**	-0.52(0.02)**	-0.921(0.049)**	-0.491(0.018)**	-0.074(0.023)**	-0.462(0.02)**	-0.836(0.049)**
	Cognition	-0.741(0.028)**	-0.248(0.063)**	-0.766(0.035)**	-0.832(0.058)**	-0.665(0.028)**	-0.19(0.063)**	-0.689(0.036)**	-0.752(0.06)**
Treatment 3	ADL	-0.588(0.01)**	-0.029(0.018)	-0.579(0.012)**	-0.936(0.022)**	-0.508(0.01)**	-0.019(0.018)	-0.499(0.012)**	-0.825(0.023)**
	IADL	-0.576(0.012)**	-0.027(0.019)	-0.557(0.014)**	-0.959(0.028)**	-0.498(0.012)**	-0.014(0.019)	-0.479(0.014)**	-0.85(0.028)**
	Cognition	-0.672(0.019)**	-0.047(0.053)	-0.711(0.023)**	-0.794(0.033)**	-0.577(0.019)**	0.02(0.053)	-0.612(0.024)**	-0.698(0.034)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user
* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample
* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group
* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group
* All results incorporating entropy balancing (EB) weights.
* ADL: activities of daily living; IADL: instrumental activities of daily living
* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1
* About 3% of samples with missing values (ADL, IADL, cognition) were treated in 2 different ways in this sensitivity analysis
  − positive analysis: Samples are treated as if they maintained same health condition during 1 year follow−up
  − negative analysis: Samples are treated as if their health condition deteriorated to a state equivalent to death during 1 year follow−up

[Appendix 4.5] Effect of LTC place on health, by using dementia as a criterion for determining severity

		Without adjustment		Adjustment of covariates using EB weighting	
		Dementia	No dementia	Dementia	No dementia
Treatment 1	Death	0.101(0.003) **	0.142(0.006) **	0.056(0.004) **	0.077(0.009) **
	ADL	−0.924(0.013) **	−1.044(0.018) **	−0.554(0.017) **	−0.621(0.032) **
	IADL	−1.013(0.014) **	−1.113(0.019) **	−0.581(0.021) **	−0.657(0.036) **
	Cognition	−1.285(0.021) **	−1.716(0.036) **	−0.684(0.027) **	−0.878(0.063) **
Treatment 2	Death	0.072(0.003) **	0.099(0.004) **	0.038(0.003) **	0.057(0.005) **
	ADL	−0.821(0.01) **	−0.929(0.014) **	−0.546(0.011) **	−0.682(0.019) **
	IADL	−0.889(0.011) **	−0.967(0.014) **	−0.555(0.014) **	−0.635(0.022) **
	Cognition	−1.094(0.016) **	−1.429(0.026) **	−0.597(0.018) **	−0.761(0.038) **
Treatment 3	Death	0.098(0.003) **	0.14(0.006) **	0.054(0.004) **	0.076(0.009) **
	ADL	−0.859(0.012) **	−1.011(0.018) **	−0.503(0.017) **	−0.593(0.032) **
	IADL	−0.944(0.014) **	−1.08(0.019) **	−0.531(0.02) **	−0.632(0.036) **
	Cognition	−1.205(0.021) **	−1.671(0.036) **	−0.635(0.027) **	−0.854(0.061) **

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as IC group

* EB: entropy balancing; ADL: activities of daily living; IADL: instrumental activities of daily living

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.6] Saturated model for effect modification of initial health status on health affecting factors, weighted regression results

	Depression			Fracture			Preventable hospitalization		
	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3
Intercept	0.02(0.00)**	0.02(0.00)**	0.02(0.00)**	0.04(0.00)**	0.05(0.00)**	0.04(0.00)**	0.13(0.00)**	0.14(0.00)**	0.13(0.00)**
IC	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.06(0.01)**	0.05(0.01)**	0.06(0.01)**
IC*severity2	−0.00(0.00)	−0.00(0.00)	0.00(0.00)	0.00(0.00)	−0.00(0.00)	0.02(0.00)**	−0.00(0.01)	−0.00(0.01)	0.02(0.01)**
IC*severity3	−0.00(0.00)	−0.00(0.00)	−0.00(0.00)	0.03(0.00)**	0.03(0.00)**	0.02(0.00)**	0.03(0.01)**	0.03(0.01)**	0.03(0.01)**
Severity 2	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.02(0.00)**	0.02(0.00)**	0.02(0.00)**	0.01(0.00)	0.01(0.00)	0.01(0.00)
Severity 3	0.01(0.00)**	0.01(0.00)**	0.01(0.00)**	0.02(0.00)**	0.02(0.00)**	0.02(0.00)**	−0.00(0.00)	−0.00(0.00)	−0.00(0.00)
	ER1			ER2					
	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3			
Intercept	0.12(0.00)**	0.12(0.00)**	0.12(0.00)**	0.28(0.00)**	0.28(0.00)**	0.28(0.00)**			
IC	−0.02(0.00)**	−0.02(0.00)**	−0.02(0.00)**	0.01(0.01)*	0.01(0.01)	0.02(0.01)**			
IC*severity2	0.04(0.00)**	0.03(0.00)**	0.03(0.00)**	0.02(0.01)**	0.02(0.01)**	0.06(0.01)**			
IC*severity3	0.05(0.00)**	0.05(0.00)**	0.04(0.00)**	0.06(0.01)**	0.06(0.01)**	0.07(0.01)**			
Severity 2	−0.07(0.00)**	−0.07(0.00)**	−0.07(0.00)**	−0.07(0.00)**	−0.06(0.01)**	−0.06(0.00)**			
Severity 3	−0.10(0.00)**	−0.09(0.00)**	−0.09(0.00)**	−0.10(0.01)**	−0.10(0.01)**	−0.10(0.00)**			

* Treat variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Severest group (grade 1−2) was used as a reference value (=1). Severity 2: grade 3−4; Severity 3: grade 5.

* Treat 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treat 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treat 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* All results adjusting baseline covariates by applying weighted regression adopting entropy balancing weight

* ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.7] Effect of LTC place on factors affecting healthy ageing, using IPTW derived from logistic regression and CBPS

		IPTW, logistic regression				IPTW, CBPS			
		Total	Grade 1−2	Grade 3−4	Grade 5	Total	Grade 1−2	Grade 3−4	Grade 5
Treatment 1	Depression	0.004(0.002)+	0.005(0.005)	0.005(0.003)	0.002(0.005)	0.004(0.002)	0.004(0.004)	0.003(0.002)	0.001(0.005)
	Fracture	0.016(0.004)**	0.01(0.005)+	0.016(0.006)**	0.037(0.009)**	0.014(0.003)**	0.009(0.005)+	0.012(0.004)**	0.037(0.009)**
	PH	0.066(0.007)**	0.06(0.008)**	0.064(0.011)**	0.088(0.013)**	0.062(0.005)**	0.059(0.008)**	0.057(0.006)**	0.085(0.012)**
	ER1	0.015(0.004)**	-0.014(0.008)+	0.016(0.005)**	0.029(0.007)**	0.013(0.003)**	-0.016(0.007)*	0.013(0.004)**	0.028(0.007)**
	ER2	0.043(0.007)**	0.017(0.01)+	0.046(0.012)**	0.058(0.012)**	0.036(0.005)**	0.014(0.009)	0.035(0.006)**	0.058(0.012)**
Treatment 2	Depression	0.003(0.002)+	0.003(0.004)	0.004(0.003)	0.002(0.005)	0.003(0.002)	0.002(0.004)	0.003(0.002)	0.001(0.005)
	Fracture	0.013(0.004)**	0.009(0.005)+	0.012(0.005)*	0.034(0.009)**	0.011(0.003)**	0.008(0.005)	0.009(0.004)*	0.034(0.009)**
	PH	0.057(0.006)**	0.052(0.008)**	0.055(0.009)**	0.08(0.012)**	0.054(0.004)**	0.051(0.008)**	0.049(0.005)**	0.078(0.012)**
	ER1	0.014(0.003)**	-0.013(0.007)+	0.015(0.005)**	0.027(0.007)**	0.012(0.003)**	-0.015(0.007)*	0.012(0.003)**	0.027(0.007)**
	ER2	0.034(0.006)**	0.011(0.01)	0.035(0.01)**	0.05(0.012)**	0.028(0.005)**	0.008(0.009)	0.026(0.006)**	0.051(0.012)**
Treatment 3	Depression	0.008(0.002)**	0.007(0.003)*	0.009(0.002)**	0.003(0.003)	0.007(0.001)**	0.006(0.003)+	0.008(0.002)**	0.003(0.003)
	Fracture	0.026(0.002)**	0.01(0.004)*	0.028(0.003)**	0.033(0.005)**	0.025(0.002)**	0.009(0.004)*	0.026(0.002)**	0.033(0.005)**
	PH	0.083(0.003)**	0.063(0.007)**	0.084(0.004)**	0.088(0.007)**	0.081(0.003)**	0.062(0.007)**	0.082(0.003)**	0.088(0.007)**
	ER1	0.011(0.002)**	-0.018(0.006)**	0.013(0.002)**	0.018(0.004)**	0.01(0.002)**	-0.018(0.005)**	0.013(0.002)**	0.017(0.004)**
	ER2	0.078(0.004)**	0.028(0.008)**	0.083(0.004)**	0.088(0.007)**	0.074(0.003)**	0.026(0.008)**	0.079(0.004)**	0.087(0.007)**

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as RC group

* IPTW: inverse probability of treatment weighting; CBPS: covariate balance propensity score; PH: preventable hospitalization; ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.8] Effect of LTC place on factors affecting healthy ageing, using different strategy defining treatment

		Without adjustment				Adjustment of covariates using EB weighting			
		Total	Grade 1-2	Grade 3-4	Grade 5	Total	Grade 1-2	Grade 3-4	Grade 5
Treatment 4	Depression	-0.005(0.001)**	-0.003(0.002)	-0.004(0.001)**	0.001(0.005)	0.007(0.002)**	0.007(0.004)	0.007(0.003)*	0.005(0.006)
	Fracture	-0.001(0.002)	0.004(0.004)	-0.003(0.002)	0.029(0.007)**	0.015(0.003)**	0.008(0.005)+	0.012(0.004)**	0.037(0.009)**
	PH	0.042(0.003)**	0.043(0.006)**	0.04(0.003)**	0.063(0.009)**	0.055(0.004)**	0.056(0.008)**	0.047(0.005)**	0.087(0.012)**
	ER1	0.012(0.002)**	-0.028(0.005)**	0.006(0.002)**	0.021(0.005)**	0.012(0.003)**	-0.015(0.006)*	0.013(0.003)**	0.026(0.007)**
	ER2	0.021(0.003)**	-0.016(0.007)**	0.011(0.004)**	0.053(0.01)**	0.029(0.004)**	0.015(0.009)+	0.025(0.005)**	0.057(0.012)**
Treatment 5	Depression	-0.001(0.001)	0(0.002)	0(0.001)	0.002(0.003)	0.007(0.002)**	0.006(0.004)	0.007(0.003)**	0.006(0.005)
	Fracture	0.015(0.002)**	0.008(0.003)*	0.015(0.002)**	0.032(0.005)**	0.017(0.003)**	0.011(0.005)*	0.014(0.003)**	0.037(0.009)**
	PH	0.06(0.002)**	0.049(0.006)**	0.06(0.003)**	0.073(0.006)**	0.06(0.004)**	0.059(0.008)**	0.053(0.005)**	0.088(0.012)**
	ER1	-0.006(0.001)**	-0.048(0.005)**	-0.008(0.002)**	0(0.003)	0.006(0.003)*	-0.028(0.006)**	0.008(0.003)*	0.021(0.006)**
	ER2	0.042(0.003)**	-0.019(0.007)**	0.039(0.003)**	0.07(0.007)**	0.034(0.004)**	0.011(0.009)	0.031(0.005)**	0.062(0.012)**

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user or home and community base care (HC) user

* Treatment 4: Intention to treat (ITT) approach. Treatment variable assigned according to first service utilized.

* Treatment 5: Operational definition approach. Switch users (used both services within follow-up period) who utilized RC more than half of the survival time were treated as RC user.

* EB: entropy balancing; PH: preventable hospitalization; ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment

* Reported values are average treatment effect (standard error). **, p-value<0.01; *, p-value<0.05; +, p-value<0.1

[Appendix 4.9] Effect of LTC place on factors affecting healthy ageing, by using dementia as a criterion for determining severity

		Without adjustment		Adjustment of covariates using EB weighting	
		Dementia	No dementia	Dementia	No dementia
Treatment 1	Depression	−0.006(0.001) **	−0.005(0.002) *	0.004(0.002)	0.01(0.005) *
	Fracture	0.003(0.002)	−0.002(0.003)	0.017(0.003) **	0.023(0.007) **
	PH	0.045(0.003) **	0.047(0.005) **	0.061(0.005) **	0.067(0.01) **
	ER1	0.016(0.002) **	0.025(0.004) **	0.014(0.003) **	0.025(0.007) **
	ER2	0.035(0.004) **	0.03(0.006) **	0.042(0.005) **	0.043(0.01) **
Treatment 2	Depression	−0.003(0.001) *	0(0.002)	0.005(0.002) **	0.015(0.003) **
	Fracture	0.014(0.002) **	0.021(0.003) **	0.024(0.002) **	0.037(0.004) **
	PH	0.064(0.003) **	0.076(0.004) **	0.076(0.003) **	0.093(0.006) **
	ER1	0.014(0.002) **	0.021(0.003) **	0.01(0.002) **	0.023(0.004) **
	ER2	0.06(0.003) **	0.084(0.004) **	0.068(0.003) **	0.111(0.006) **
Treatment 3	Depression	−0.007(0.001) **	−0.005(0.002) *	0.003(0.002)	0.009(0.005) *
	Fracture	0(0.002)	−0.004(0.003)	0.013(0.003) **	0.021(0.007) **
	PH	0.036(0.003) **	0.043(0.005) **	0.052(0.005) **	0.062(0.009) **
	ER1	0.015(0.002) **	0.025(0.004) **	0.013(0.003) **	0.025(0.007) **
	ER2	0.026(0.004) **	0.024(0.006) **	0.032(0.005) **	0.037(0.009) **

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as IC group

* EB: entropy balancing; PH: preventable hospitalization; ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 4.10] Sensitivity analysis results, removing users who ever entered long-term care hospital during follow-up

	Treat 1				Treat 2				Treat 3			
	Total	Grade 1-2	Grade 3-4	Grade 5	Total	Grade 1-2	Grade 3-4	Grade 5	Total	Grade 1-2	Grade 3-4	Grade 5
Death	0.06(0)**	0.04(0.01)**	0.06(0.01)**	0.06(0.01)**	0.04(0)**	0(0.01)	0.04(0)**	0.04(0.01)**	0.06(0)**	0.05(0.01)**	0.06(0.01)**	0.06(0.01)**
ADL	-0.52(0.02)**	-0.05(0.03)+	-0.51(0.02)**	-0.84(0.05)**	-0.57(0.01)**	-0.02(0.02)	-0.56(0.01)**	-0.89(0.03)**	-0.49(0.02)**	-0.06(0.03)*	-0.47(0.02)**	-0.79(0.05)**
IADL	-0.57(0.02)**	-0.09(0.03)**	-0.55(0.03)**	-0.94(0.07)**	-0.57(0.01)**	-0.04(0.02)	-0.56(0.02)**	-0.93(0.03)**	-0.54(0.02)**	-0.1(0.03)**	-0.52(0.03)**	-0.89(0.06)**
Cognition	-0.85(0.03)**	-0.25(0.08)**	-0.88(0.04)**	-0.96(0.08)**	-0.76(0.02)**	-0.04(0.06)	-0.8(0.03)**	-0.89(0.04)**	-0.81(0.03)**	-0.28(0.08)**	-0.84(0.04)**	-0.91(0.07)**
Depression	0.01(0)*	0.01(0.01)	0.01(0)+	0.01(0.01)	0.01(0)**	0.01(0)*	0.01(0)**	0.01(0)	0.01(0)*	0.01(0.01)	0.01(0)+	0.01(0.01)
Fracture	0.01(0)**	0.01(0.01)	0.01(0)*	0.03(0.01)*	0.02(0)**	0.01(0)	0.02(0)**	0.02(0.01)**	0.01(0)*	0.01(0.01)	0.01(0)	0.03(0.01)*
PH	0.06(0.01)**	0.07(0.01)**	0.05(0.01)**	0.11(0.02)**	0.08(0)**	0.07(0.01)**	0.08(0)**	0.08(0.01)**	0.06(0.01)**	0.06(0.01)**	0.05(0.01)**	0.1(0.02)**
ER1	0.01(0)**	-0.01(0.01)	0.01(0)**	0.03(0.01)**	0.01(0)**	-0.02(0.01)**	0.01(0)**	0.01(0)**	0.01(0)**	-0.01(0.01)	0.01(0)**	0.03(0.01)**
ER2	0.03(0.01)**	0.02(0.01)+	0.02(0.01)**	0.05(0.02)**	0.06(0)**	0.03(0.01)**	0.07(0)**	0.06(0.01)**	0.02(0.01)**	0.01(0.01)	0.02(0.01)**	0.05(0.02)**

* Treat variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treat 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treat 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treat 3: Subjects who are switch users (used both services within follow-up period) were treated as IC group

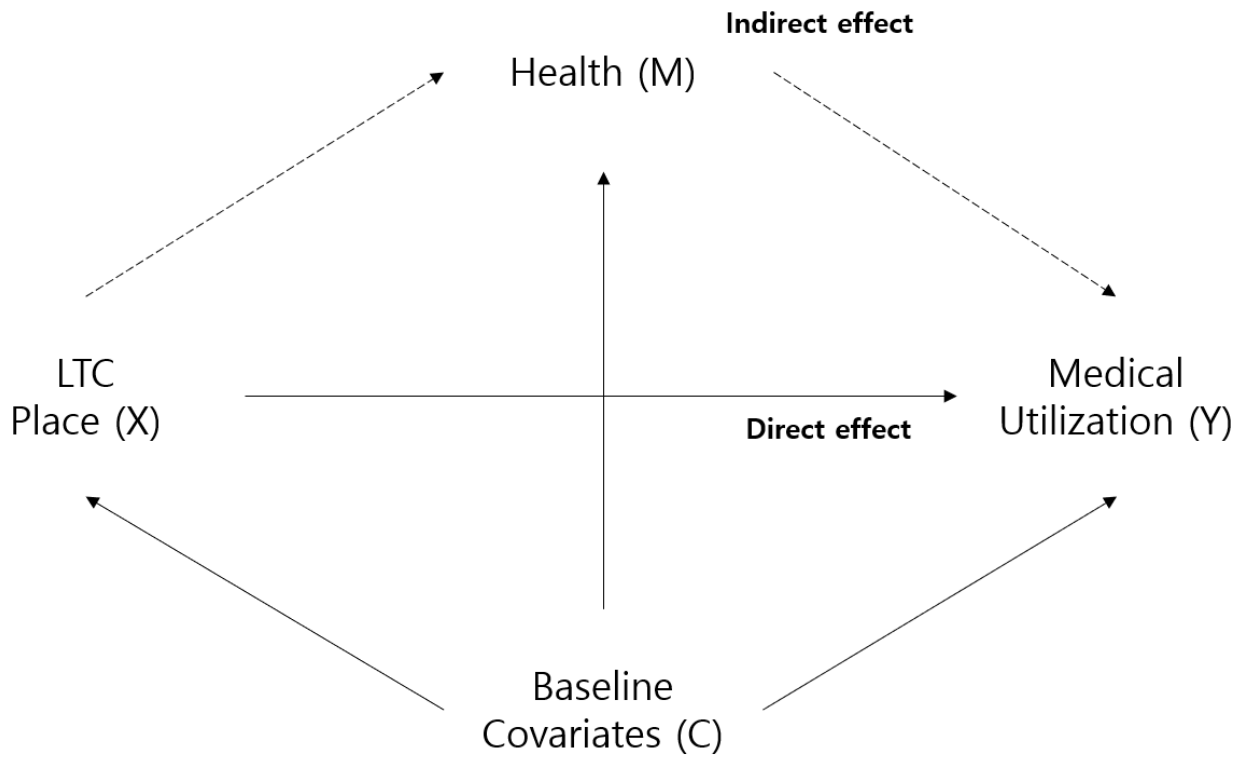
* PH: preventable hospitalization; ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment

* All results adjusting baseline covariates by applying weighted regression adopting entropy balancing weight

* Reported values are average treatment effect (standard error). **, p-value<0.01; *, p-value<0.05; +, p-value<0.1

[Appendix 5.1] Supplements regarding causal mediation analysis

A. Static version of causal diagram reflecting mediation hypothesis.



B. Results of causal mediation analysis

		Analysis 1			Analysis 2		
		Grade 1−2	Grade 3−4	Grade 5	Grade 1−2	Grade 3−4	Grade 5
Total medical services	NDE	−1,066,000 **	−858,913 **	−524,091 *	−5,830,491 **	−4,089,284 **	−5,109,557 **
		(212,294)	(71,268)	(213,143)	(384,934)	(142,411)	(312,086)
	NIE	255,576 *	2,613,639 **	2,906,196 **	3,599,396 **	4,339,179 **	5,249,674 **
		(129,231)	(353,349)	(163,508)	(428,189)	(399,867)	(354,275)
Outpatient services	NDE	−275,624 **	−107,911 **	−187,849 **	−926,498 **	−280,928 **	−315,108 **
		(32,661)	(17,388)	(31,163)	(92,938)	(32,468)	(57,216)
	NIE	106,843 *	647,981 **	51,317	1,449,928 **	1,626,573 **	129,312 **
		(47,961)	(154,054)	(37,199)	(197,921)	(231,905)	(84,653)
Inpatient services	NDE	−790,376 **	−752,001 **	−336,241	−4,903,994 **	−3,808,356 **	−4,794,449 **
		(213,229)	(81,063)	(226,457)	(348,211)	(104,861)	(355,788)
	NIE	148,733 +	1,965,658 **	2,854,878 **	2,149,468 **	2,712,607 **	5,120,363 **
		(90,127)	(136,633)	(121,715)	(279,204)	(180,669)	(301,613)

* NDE: Natural Direct Effect; NIE: Natural Indirect Effect

* Effect of IC (Institutional Care) use on medical costs was decomposed using causal mediation analysis, by treating four health related variables (ADL, IADL, cognitive status, death) jointly as mediator. Population average effect was estimated using R package 'medflex', and standard error based on bootstrapping had been reported.

* ADL: activities of daily living; IADL: instrumental activities of daily living

* Covariates suggested in Table 2.2 are adjusted in order to estimate population average effect

* Analysis 1: Medical costs during first 1 year of follow−up was used as dependent variable, and only samples who did not switched there LTC place during 1 years of follow−up was used

* Analysis 2: Medical costs during first 2 year of follow−up was used as dependent variable, and only samples who did not switched there LTC place during 2 years of follow−up was used

* Reported values are population average effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 5.2] Difference in health care payout, due to LTC place (covariate adjusted using EB weights), sensitivity analysis results applying different treatment verifications

Treatment 2	Total		Grade 1−2		Grade 3−4		Grade 5	
	HC	IC−HC	HC	IC−HC	HC	IC−HC	HC	IC−HC
0. LTCI + NHI service	13,328,493	5,451,272**	14,610,224	4,433,851**	13,486,985	5,553,861**	11,864,499	5,625,446**
	(23,687)	(76,952)	(117,177)	(252,247)	(26,910)	(95,336)	(42,852)	(144,538)
1. LTCI service	7,106,075	4,663,785**	5,725,792	5,901,716**	7,162,765	4,751,964**	7,556,165	3,534,428**
	(9,870)	(39,194)	(42,568)	(123,904)	(10,976)	(47,583)	(24,366)	(84,122)
2. NHI service	6,223,223	786,682**	8,883,289	−1,466,722**	6,325,345	800,772**	4,308,729	2,090,623**
	(24,052)	(82,279)	(118,062)	(252,823)	(27,376)	(102,519)	(42,075)	(155,723)
2.1 Outpatient service	1,522,745	−506,817**	1,403,598	−548,078**	1,619,671	−559,306**	1,119,650	−193,609**
	(7,634)	(17,745)	(27,196)	(40,436)	(9,349)	(23,674)	(10,386)	(21,478)
2.2 Inpatient service	4,700,478	1,293,498**	7,479,691	−918,644**	4,705,674	1,360,078**	3,189,079	2,284,232**
	(22,139)	(78,809)	(113,255)	(246,973)	(24,843)	(97,396)	(40,081)	(154,414)
Treatment 3	Total		Grade 1−2		Grade 3−4		Grade 5	
	HC	IC−HC	HC	IC−HC	HC	IC−HC	HC	IC−HC
0. LTCI + NHI service	13,722,226	4,982,330**	15,094,494	4,023,038*	13,872,164	5,119,362**	12,266,896	4,721,962**
	(22,928)	(127,423)	(110,894)	(290,245)	(26,159)	(165,578)	(41,797)	(256,121)
1. LTCI service	7,420,879	4,461,596**	6,265,867	5,434,683**	7,460,594	4,774,099**	7,835,857	2,347,340**
	(9,824)	(66,582)	(43,187)	(158,986)	(10,942)	(81,675)	(23,927)	(163,379)
2. NHI service	6,302,091	519,890**	8,827,628	−1,410,646**	6,412,604	344,229+	4,431,386	2,374,275**
	(23,213)	(136,876)	(111,666)	(286,806)	(26,540)	(177,405)	(40,766)	(274,513)
2.1 Outpatient service	1,517,500	−637,973**	1,391,216	−609,760**	1,615,631	−698,982**	1,116,760	−322,644**
	(7,437)	(23,805)	(25,758)	(46,583)	(9,155)	(33,557)	(9,958)	(26,237)
2.2 Inpatient service	4,784,591	1,157,863**	7,436,412	−800,886**	4,796,972	1,043,211**	3,314,626	2,696,919**
	(21,340)	(132,396)	(107,118)	(282,214)	(24,047)	(169,676)	(38,902)	(273,941)

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC−HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW).

* If coefficient of 'IC−HC (treatment variable)' is statistically significantly different with 0, **, p−value<0.01; *, p−value<0.05; +, p−value<0.1.

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as IC group

* LTC: Long−term care; EB: Entropy balancing; LTCI: Long−term care insurance; NHI: National health insurance; LTCH: Long−term care hospital

[Appendix 5.3] Saturated model for effect modification of initial health status on health care payout, weighted regression results

	LTCI cost			NHI cost		
	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3
Intercept	5,689,145(55,978) **	5,696,372(50,018) **	6,224,325(54,700) **	9,330,526(111,364) **	9,187,913(103,690) **	9,100,392(106,260) **
IC	5,926,841(79,162) **	5,932,711(70,733) **	5,430,008(77,354) **	-1,938,660(157,493) **	-1,661,699(146,640) **	-1,792,692(150,275) **
Severity 2	1,466,927(58,960) **	1,466,388(52,709) **	1,237,315(57,643) **	-2,943,577(117,297) **	-2,877,070(109,270) **	-2,703,540(111,979) **
Severity 3	1,873,667(68,695) **	1,875,899(61,663) **	1,626,848(67,435) **	-5,030,915(137,201) **	-4,917,897(127,830) **	-4,698,599(130,999) **
IC*severity2	-821,366(83,379) **	-1,143,902(74,539) **	-613,648(81,517) **	2,290,514(165,883) **	2,389,252(154,531) **	2,068,088(158,362) **
IC*severity3	-3,355,162(97,527) **	-2,516,548(87,200) **	-3,139,711(95,363) **	4,973,990(194,031) **	3,999,200(180,779) **	4,664,613(185,261) **
	OPT cost			INPT cost		
	Treat1	Treat2	Treat3	Treat1	Treat2	Treat3
Intercept	1,514,984(29,508) **	1,486,397(28,517) **	1,470,274(27,833) **	7,815,542(105,208) **	7,701,516(97435) **	7,630,118(100,518) **
IC	-743,301(41,730) **	-605,835(40,330) **	-704,580(39,362) **	-1,195,359(148,786) **	-1,055,864(137,793) **	-1,088,112(142,154) **
Severity 2	133,569(31,080) **	129,649(30,052) **	140,481(29,331) **	-3,077,145(110,812) **	-3,006,718(102,678) **	-2,844,021(105,928) **
Severity 3	-400,721(36,353) **	-383,565(35,156) **	-366,814(34,313) **	-4,630,194(129,616) **	-4,534,332(120,119) **	-4,331,785(123,920) **
IC*severity2	7,164(43,953)	34,663(42,500)	-2,362(41,480)	2,283,350(156,712) **	2,354,589(145,209) **	2,070,451(149,804) **
IC*severity3	456,713(51,412) **	453,162(49,719) **	425,605(48,525) **	4,517,278(183,304) **	3,546,038(169,873) **	4,239,009(175,249) **

* Treat variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Severest group (grade 1-2) was used as a reference value (=1). Severity 2: grade 3-4; Severity 3: grade 5.

* Treat 1: Subjects who are switch users (used both services within follow-up period) were removed from the study sample

* Treat 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group

* Treat 3: Subjects who are switch users (used both services within follow-up period) were treated as RC group

* All results adjusting baseline covariates by applying weighted regression adopting entropy balancing weight

* LTCI: Long-term care insurance; NHI: National health insurance; OPT: Outpatient service use; INPT: Inpatient service use

* Reported values are average treatment effect (standard error). **, p-value<0.01; *, p-value<0.05; +, p-value<0.1

[Appendix 5.4] Difference in health care payout, due to LTC place (covariate adjusted using EB weights), sensitivity analysis results using 'mean payouts per survived days'

	Total		Grade 1-2		Grade 3-4		Grade 5	
	HC	IC-HC	HC	IC-HC	HC	IC-HC	HC	IC-HC
0. LTCI + NHI service	44,973	16,273**	64,821	12,387	44,903	16,717**	34,587	15,973**
	(108)	(502)	(614)	(1,249)	(119)	(639)	(150)	(923)
1. LTCI service	20,859	14,500**	20,141	19,862**	20,891	15,255**	21,060	7,701**
	(27)	(176)	(134)	(396)	(29)	(214)	(66)	(439)
2. NHI service	24,115	1,772**	44,673	-7,468**	24,014	1,460*	13,528	8,271**
	(110)	(547)	(625)	(1,365)	(122)	(696)	(151)	(1,018)
2.1 Outpatient service	4,837	-1,890**	5,609	-2,009**	5,085	-2,076**	3,209	-833**
	(24)	(80)	(104)	(283)	(29)	(107)	(31)	(82)
2.2 Inpatient service	19,277	3,662**	39,064	-5,460**	18,928	3,536**	10,318	9,104**
	(105)	(534)	(611)	(1,335)	(115)	(675)	(146)	(1,009)

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC-HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW).

* If coefficient of 'IC-HC (treatment variable)' is statistically significantly different with 0, **, p-value<0.01; *, p-value<0.05; +, p-value<0.1.

* LTC: Long-term care; EB: Entropy balancing; LTCI: Long-term care insurance; NHI: National health insurance; LTCH: Long-term care hospital

* Total payouts were divided by survived days during 1-year follow-up (365 days when sample did not expire during follow-up)

[Appendix 5.5] Difference in health care payout, due to LTC place (covariate adjusted using EB weights), sensitivity analysis results removing samples who ever used LTCH service during follow-up

	Total		Grade 1-2		Grade 3-4		Grade 5	
	HC	IC-HC	HC	IC-HC	HC	IC-HC	HC	IC-HC
0. LTCI + NHI service	11,943,150	5,159,336**	12,621,958	5,030,430**	12,153,340	5,302,202**	10,580,124	4,243,535**
	(22,262)	(135,434)	(113,024)	(319,438)	(25,616)	(161,567)	(36,260)	(304,960)
1. LTCI service	7,586,764	5,510,225**	6,350,167	6,518,842**	7,627,675	5,894,445**	7,978,841	3,093,624**
	(10,468)	(81,920)	(47,968)	(199,077)	(11,596)	(99,407)	(25,779)	(208,476)
2. NHI service	4,356,641	-351,149**	6,270,994	-1,487,615**	4,526,065	-592,643**	2,601,430	1,149,764**
	(21,100)	(134,027)	(107,470)	(292,160)	(24,477)	(155,161)	(28,724)	(303,980)
2.1 Outpatient service	1,617,023	-685,529**	1,559,821	-736,920**	1,721,460	-766,062**	1,148,913	-276,221**
	(8,832)	(27,762)	(33,006)	(61,446)	(10,823)	(36,728)	(11,298)	(36,188)
2.2 Inpatient service	2,739,618	334,380**	4,711,173	-750,695**	2,804,604	173,419	1,452,517	1,425,985**
	(17,865)	(128,358)	(98,461)	(284,039)	(20,300)	(146,440)	(24,768)	(296,107)

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC-HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW).

* If coefficient of 'IC-HC (treatment variable)' is statistically significantly different with 0, **, p-value<0.01; *, p-value<0.05; +, p-value<0.1.

* LTC: Long-term care; EB: Entropy balancing; LTCI: Long-term care insurance; NHI: National health insurance; LTCH: Long-term care hospital

* EB weights were re-calculated after removing LTCH users.

[Appendix 5.6] Difference in health care costs, due to LTC place, by using dementia as a criterion for determining severity

		Without adjustment		Adjustment of covariates using EB weighting	
		Dementia	No dementia	Dementia	No dementia
Treatment 1	Total	5,349,004(79,534) **	3,762,022(135,816) **	5,526,487(113,113) **	5,258,877(336,815) **
	LTCI cost	5,279,175(56,157) **	4,775,563(89,538) **	4,633,698(72,914) **	4,331,232(141,780) **
	NHI cost	68,702(80,502)	−1,014,043(131,503) **	891,579(123,238) **	927,130(351,898) **
	Outpatient	−529,802(12,511) **	−1,194,640(25,922) **	−388,478(15,704) **	−854,188(68,402) **
	Inpatient	598,505(78,999) **	180,597(126,720) **	1,280,057(121,989) **	1,781,318(334,611) **
Treatment 2	Total	5,168,373(62,200) **	4,086,840(98,390) **	5,491,780(73,057) **	5,595,561(166,420) **
	LTCI cost	4,982,013(40,022) **	4,602,491(59,086) **	4,661,521(43,233) **	4,260,659(74,309) **
	NHI cost	185,232(63,664) **	−516,152(97,820) **	829,074(78,079) **	1,334,373(175,836) **
	Outpatient	−442,672(11,310) **	−1,043,234(22,655) **	−283,875(12,393) **	−634,185(42,845) **
	Inpatient	627,904(61,962) **	527,082(93,076) **	1,112,950(76,463) **	1,968,558(167,145) **
Treatment 3	Total	4,882,532(78,814) **	3,580,330(135,569) **	4,997,486(109,975) **	5,009,948(325,726) **
	LTCI cost	4,846,032(56,114) **	4,597,298(89,545) **	4,201,187(71,510) **	4,157,028(139,102) **
	NHI cost	35,486(79,675)	−1,017,448(131,219) **	795,211(119,218) **	852,427(340,568) **
	Outpatient	−499,470(11,996) **	−1,159,722(25,673) **	−370,396(15,117) **	−831,936(65,775) **
	Inpatient	534,956(78,288) **	142,274(126,497) **	1,165,607(118,008) **	1,684,363(324,348) **

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user

* Treatment 1: Subjects who are switch users (used both services within follow−up period) were removed from the study sample

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as IC group

* EB: entropy balancing; PH: preventable hospitalization; ER1: visited emergency room, died or sent back; ER2: visited emergency room, received hospital treatment; LTCI: long−term care insurance; NHI: national health insurance

* Reported values are average treatment effect (standard error). **, p−value<0.01; *, p−value<0.05; +, p−value<0.1

[Appendix 5.7] Difference in inpatient service utilization patterns, due to LTC place (EB weighted regression results), sensitivity analysis results applying different treatment verifications

Treatment 2		Formal care costs		Pr (utilization=1)		Formal care costs (|utilization=1)		Inpatient days (|utilization=1)	
		HC	IC−HC	HC	IC−HC	HC	IC−HC	HC	IC−HC
LTCH use	Total	1,286,934	518,548**	0.144	0.139**	8,966,132	−2,574,435**	99.93	−23.1**
		(10,369)	(34,733)	(0.001)	(0.003)	(54,791)	(106,826)	(0.57)	(1.17)
	Grade 1−2	2,064,172	−225,730*	0.193	0.066**	10,667,794	−3,573,682**	109.03	−29.77**
		(55,754)	(103,083)	(0.003)	(0.008)	(226,255)	(350,592)	(2.09)	(3.42)
	Grade 3−4	1,234,526	528,730**	0.142	0.137**	8,716,900	−2,380,682**	97.74	−22.11**
		(11,363)	(42,552)	(0.001)	(0.004)	(60,645)	(130,942)	(0.64)	(1.41)
	Grade 5	1,139,198	896,449**	0.127	0.193**	8,996,385	−2,620,629**	104.85	−23.97**
		(22,479)	(81,709)	(0.002)	(0.008)	(128,993)	(224,718)	(1.45)	(2.71)
Acute Hospital use during last 90 days of life	Total	5,865,496	−1,399,488**	0.631	−0.036**	9,294,476	−1,785,263**	22.05	−3.05**
		(64,527)	(141,594)	(0.003)	(0.009)	(90210)	(205,586)	(0.18)	(0.43)
	Grade 1−2	5,737,893	−1,235,454**	0.589	−0.013	9,748,779	−1,925,189**	23.32	−2.23*
		(179,899)	(303,586)	(0.009)	(0.019)	(270,038)	(443,205)	(0.53)	(1.01)
	Grade 3−4	5,983,853	−1,551,581**	0.642	−0.046**	9,316,269	−1,886,669**	22.15	−3.54**
		(72,851)	(169,639)	(0.004)	(0.01)	(99,946)	(246,680)	(0.2)	(0.51)
	Grade 5	4,905,085	−463,953	0.608	0.023	8,063,267	−1,029,696+	18.47	−0.45
		(193,382)	(407,292)	(0.012)	(0.027)	(278,330)	(567,526)	(0.6)	(1.33)
Treatment 3		Formal care costs		Pr (utilization=1)		Formal care costs (|utilization=1)		Inpatient days (|utilization=1)	
		HC	IC−HC	HC	IC−HC	HC	IC−HC	HC	IC−HC
LTCH use	Total	1,294,477	701,370**	0.152	0.122**	8,531,138	−1,228,821**	95.53	−6.27**
		(9,859)	(56,692)	(0.001)	(0.005)	(49,812)	(165,841)	(0.52)	(1.96)
	Grade 1−2	2,008,722	−13,404	0.198	0.067**	10,168,732	−2,630,658**	104.28	−19.85**

		(51,918)	(123,284)	(0.003)	(0.009)	(208,555)	(395,933)	(1.93)	(3.93)
	Grade 3−4	1,243,704	629,566**	0.15	0.112**	8,312,755	−1,160,699**	93.57	−6.79**
		(10,845)	(65,853)	(0.001)	(0.006)	(55,391)	(201,784)	(0.59)	(2.32)
	Grade 5	1,170,337	1,378,076**	0.138	0.196**	8,480,676	−840,041*	99.44	−1.47
		(21,515)	(171,742)	(0.002)	(0.014)	(114,611)	(411,308)	(1.29)	(5.01)
Acute Hospital use during last 90 days of life	Total	5,796,695	−1,094,523**	0.634	−0.053**	9,147,184	−1,053,040**	21.81	−1.53*
		(60,721)	(211,315)	(0.003)	(0.012)	(84,735)	(312,591)	(0.17)	(0.64)
	Grade 1−2	5,749,511	−1,340,724**	0.596	−0.031	9,644,860	−1,849,898**	23.26	−1.89
		(170,482)	(333,242)	(0.009)	(0.022)	(253,581)	(487,045)	(0.49)	(1.2)
	Grade 3−4	5,893,061	−1,225,434**	0.644	−0.065**	9,157,714	−1,088,833**	21.85	−1.84*
		(68,296)	(259,247)	(0.004)	(0.015)	(93,683)	(389,663)	(0.19)	(0.82)
	Grade 5	4,863,809	141,086	0.615	−0.009	7,908,223	349,144	18.36	2.16
		(179,652)	(822,668)	(0.011)	(0.046)	(256,804)	(1,193,132)	(0.55)	(2.38)

* Treatment variable is place of receiving long−term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).

* Column 'HC' refers to the coefficient value of intercept, and column 'IC−HC' refers to the coefficient value of the treatment variable.

* Reported values are EB (Entropy Balancing) weight adjusted means (standard error), using Korean won (KRW), probability, and inpatient days.

* If coefficient of 'IC−HC (treatment variable)' is statistically significantly different with 0, **, p−value<0.01; *, p−value<0.05; +, p−value<0.1.

* LTC: Long−term care; EB: Entropy balancing; LTCI: Long−term care insurance; NHI: National health insurance; LTCH: Long−term care hospital

* Treatment 2: Subjects who are switch users (used both services within follow−up period) were treated as HC group

* Treatment 3: Subjects who are switch users (used both services within follow−up period) were treated as IC group

[Appendix 5.8] Comparison of medical utilization by primary causes (ICD-10 chapters), using different treatment verifications

Treatment 1			Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13	Ch 14	Ch 18	Ch 19	Ch 21
Outpatient service	Sample	HC user	17,097	207,921	7,453	49,953	134,879	81,301	58,871	12,680	114,975	47,573	39,335	19,880	204,862	433,517	37,888	64,414	18,742
		IC user	16,049	72,441	6,905	48,914	201,996	45,852	25,512	5,272	71,588	36,808	28,559	25,186	77,564	130,479	39,299	48,968	5,695
		p-value	0.1087	<.0001	0.7332	0.3673	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	0.155	<.0001	<.0001
	Grade 12	HC user	19,161	312,099	6,250	34,099	69,645	125,398	26,130	6,039	116,264	46,486	33,753	23,206	98,117	382,937	40,501	54,779	25,461
		IC user	15,506	103,639	7,557	43,779	108,953	45,699	11,612	3,899	70,719	36,245	28,089	35,815	43,829	144,608	43,131	36,748	6,502
		p-value	0.0526	<.0001	0.577	0.0006	<.0001	<.0001	<.0001	<.0001	<.0001	0.0001	0.0288	0.0005	<.0001	<.0001	0.3569	<.0001	<.0001
	Grade 34	HC user	17,480	224,993	7,990	52,041	115,752	80,421	63,190	13,330	119,194	48,279	40,945	20,288	224,004	501,451	37,900	66,224	19,975
		IC user	16,421	69,936	7,521	50,720	194,286	47,211	27,969	5,751	75,078	37,865	29,985	24,435	83,309	159,913	39,338	49,764	6,575
		p-value	0.1923	<.0001	0.822	0.3545	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0163	<.0001	<.0001	0.2375	<.0001	<.0001
	Grade 5	HC user	14,065	68,782	5,403	48,353	260,696	60,258	55,870	13,142	94,049	44,558	34,763	16,177	171,135	135,982	36,270	60,885	9,080
		IC user	17,055	60,621	4,162	43,293	268,574	36,500	23,958	3,384	61,750	32,388	21,789	24,765	72,493	32,432	36,895	53,428	3,052
		p-value	0.1054	0.6028	0.4461	0.0829	0.3622	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0382	<.0001	<.0001	0.8092	0.0233	<.0001
LTCH service	Sample	HC user	20,766	121,556	1,558	28,473	388,886	248,365	827	151	215,611	58,676	10,721	14,287	34,460	60,035	8,589	75,359	1,979
		IC user	39,111	115,966	3,057	51,769	854,619	324,716	957	194	251,678	103,552	19,191	25,343	49,884	49,938	18,536	102,807	553
		p-value	<.0001	0.4956	0.1312	<.0001	<.0001	<.0001	0.8003	0.805	0.005	<.0001	0.0008	0.0001	0.0019	0.1466	0.0005	0.0002	0.0017
	Grade 12	HC user	52,001	253,942	2,962	39,027	314,991	537,997	3,236	451	477,937	117,899	14,225	37,564	36,969	84,613	17,268	87,702	4,142
		IC user	60,207	105,759	1,511	41,141	431,680	451,176	3,142	-	431,279	179,600	14,147	56,193	24,267	82,137	16,926	110,131	3,013
		p-value	0.4628	<.0001	0.4745	0.836	0.003	0.0809	0.9796	0.2776	0.3304	0.0011	0.9878	0.1166	0.1797	0.9116	0.9484	0.3788	0.6829
	Grade 34	HC user	18,919	119,683	1,709	29,734	364,277	233,224	624	123	203,109	56,352	10,963	13,348	37,694	61,394	8,068	76,025	1,685
		IC user	37,820	139,547	3,825	59,602	739,033	320,308	1,024	236	228,180	99,811	17,321	22,883	51,020	48,981	17,351	101,850	32
		p-value	<.0001	0.066	0.1116	<.0001	<.0001	<.0001	0.4581	0.6015	0.0811	<.0001	0.0236	0.0022	0.0338	0.1068	0.007	0.0032	<.0001
	Grade 5	HC user	13,728	59,698	255	17,357	544,679	174,597	721	133	143,798	39,920	7,597	7,000	17,246	39,713	6,977	66,592	2,288
		IC user	24,731	27,915	-	23,065	1,570,778	303,392	-	-	258,881	94,725	26,342	20,481	64,611	30,908	22,410	103,254	1,045
		p-value	0.1529	0.0085	0.0206	0.4798	<.0001	0.0296	0.1547	0.284	0.005	0.0068	0.0874	0.1129	0.0034	0.6999	0.1314	0.0754	0.3897
Acute hospital service	Sample	HC user	124,942	598,103	15,351	68,082	22,839	140,549	15,100	4,980	467,602	413,711	185,057	24,027	155,979	232,373	60,116	328,030	77,988
		IC user	205,906	405,660	12,656	59,324	48,041	125,757	8,573	1,937	360,716	696,169	220,495	41,591	134,581	319,095	111,324	411,643	58,700
		p-value	<.0001	<.0001	0.3109	0.0779	<.0001	0.1176	<.0001	<.0001	<.0001	<.0001	0.0016	0.001	0.049	<.0001	<.0001	<.0001	0.0088
	Grade 12	HC user	217,049	1,159,162	28,622	75,614	26,677	350,326	10,879	2,520	591,453	904,584	260,711	66,603	115,227	385,181	104,436	290,998	164,870
		IC user	261,516	631,702	14,875	92,087	17,405	156,745	4,314	475	417,986	1,106,120	232,396	95,517	54,869	412,098	121,180	209,043	43,430
		p-value	0.1454	<.0001	0.1118	0.3011	0.0981	<.0001	0.0028	0.0026	0.0017	0.0063	0.3261	0.327	0.0003	0.4959	0.4052	0.0026	<.0001
	Grade 34	HC user	126,327	615,403	15,295	74,423	20,872	132,024	15,898	5,203	480,780	399,059	187,140	22,050	176,972	239,748	58,013	336,872	79,257
		IC user	200,112	409,580	11,635	58,377	49,042	116,599	9,768	2,282	353,989	680,970	237,870	41,776	151,449	335,709	110,586	434,829	73,677
		p-value	<.0001	<.0001	0.2348	0.0075	<.0001	0.1419	<.0001	0.0034	<.0001	<.0001	0.0004	0.0009	0.067	<.0001	<.0001	<.0001	0.5683
	Grade 5	HC user	70,775	205,143	8,455	33,390	30,845	63,421	13,479	5,246	341,987	219,881	133,299	10,699	78,942	114,745	46,605	305,169	26,342
		IC user	224,097	247,116	20,489	39,467	53,507	128,458	6,500	404	384,182	583,648	139,311	23,524	80,097	172,053	120,297	404,897	22,517
		p-value	0.0017	0.4235	0.2483	0.4381	0.0694	0.0411	0.0131	<.0001	0.4338	<.0001	0.7878	0.1321	0.9627	0.0653	0.0371	0.0291	0.8051
Other hospital service	Sample	HC user	14,749	57,490	788	7,742	27,273	72,524	23,782	1,202	74,657	40,035	10,566	4,162	69,141	20,206	4,578	86,089	2,432
		IC user	41,065	44,607	1,875	10,847	174,809	44,410	12,605	434	73,450	114,508	18,350	7,360	47,728	51,198	12,469	106,300	2,460
		p-value	<.0001	0.0298	0.0252	0.0244	<.0001	0.0004	<.0001	<.0001	0.8743	<.0001	<.0001	0.0255	<.0001	<.0001	<.0001	0.0005	0.9825
	Grade 12	HC user	17,645	122,517	620	3,930	19,394	182,424	9,902	533	175,078	53,033	7,775	6,687	27,488	28,079	7,448	62,480	11,674
		IC user	32,369	85,561	701	6,821	78,292	81,432	4,565	21	182,746	152,752	15,688	7,155	21,035	63,350	21,343	54,507	2,212
		p-value	0.0491	0.0328	0.9003	0.1807	0.0001	<.0001	0.0004	0.002	0.8541	<.0001	0.0463	0.892	0.5503	0.002	0.1127	0.4502	0.0579
	Grade 34	HC user	14,934	58,970	850	8,168	25,524	69,844	25,471	1,208	72,292	39,808	10,518	4,357	79,033	20,774	4,474	89,076	1,874
		IC user	46,341	41,347	2,271	8,935	169,069	34,951	13,925	457	53,070	113,746	19,719	8,106	44,808	54,631	13,671	105,252	2,994
		p-value	<.0001	0.0146	0.0322	0.5775	<.0001	<.0001	<.0001	<.0001	0.0052	<.0001	<.0001	0.0334	<.0001	<.0001	<.0001	0.0099	0.5091
	Grade 5	HC user	12,524	15,995	576	7,778	40,377	24,388	23,062	1,540	32,695	34,610	12,430	1,977	44,128	12,825	3,552	83,767	441
		IC user	18,010	21,428	1,512	18,589	209,713	26,105	11,930	449	129,776	95,657	17,331	5,477	84,207	26,609	4,452	163,777	-
		p-value	0.3651	0.6308	0.3832	0.1249	<.0001	0.9403	0.0004	0.0025	0.0005	0.0017	0.2663	0.2687	0.0185	0.0533	0.616	0.0063	0.0302

Treatment 2			Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13	Ch 14	Ch 18	Ch 19	Ch 21
Outpatient service	Sample	HC user	16,892	203,561	7,328	49,530	135,183	79,814	58,125	12,558	114,000	47,145	38,866	19,662	201,326	418,587	37,549	63,709	18,235
		IC user	17,257	100,411	6,736	51,337	217,407	62,788	28,608	6,862	83,315	40,965	31,333	25,756	96,536	131,699	43,811	63,900	7,017
		p-value	0.5488	<.0001	0.7045	0.0644	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.8453	<.0001
	Grade 12	HC user	18,912	307,369	6,164	33,907	70,029	122,718	26,062	6,047	115,286	45,905	33,434	23,005	97,815	377,016	40,079	54,291	24,992
		IC user	16,423	118,449	7,594	43,384	115,027	64,217	14,706	4,794	88,489	38,058	31,169	33,251	56,516	128,680	44,410	43,107	6,900
		p-value	0.1742	<.0001	0.5183	0.0001	<.0001	<.0001	<.0001	0.0135	<.0001	0.0025	0.3692	0.0007	<.0001	<.0001	0.097	<.0001	<.0001
	Grade 34	HC user	17,260	219,904	7,847	51,562	116,279	78,898	62,342	13,194	118,103	47,822	40,431	20,056	219,968	482,852	37,547	65,445	19,389
		IC user	17,746	107,777	6,835	53,331	207,294	66,154	30,485	7,165	85,294	41,700	32,407	25,506	104,767	155,912	44,377	65,655	7,753
		p-value	0.5199	<.0001	0.615	0.1434	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.8576	<.0001
	Grade 5	HC user	13,955	68,042	5,353	48,210	259,943	59,722	55,351	13,034	93,607	44,282	34,439	16,037	168,616	133,271	36,058	60,486	8,976
		IC user	16,240	58,384	5,670	47,359	308,317	48,877	27,507	6,507	72,874	39,527	27,199	24,495	87,408	43,115	39,783	68,726	4,010
		p-value	0.0701	0.3283	0.8534	0.6838	<.0001	0.0005	<.0001	<.0001	<.0001	0.0027	<.0001	0.0004	<.0001	<.0001	0.0331	0.0014	0.0018
LTCH service	Sample	HC user	20,784	120,500	1,567	28,397	390,882	245,771	822	153	214,753	58,838	10,691	14,370	34,008	59,043	8,600	75,188	1,970
		IC user	36,378	100,952	2,967	48,632	689,458	324,617	2,369	171	250,563	95,543	17,126	27,166	39,904	44,692	15,480	108,269	970
		p-value	<.0001	0.0009	0.0494	<.0001	<.0001	<.0001	0.0592	0.894	0.0003	<.0001	0.0008	<.0001	0.0778	0.0034	0.0003	<.0001	0.049
	Grade 12	HC user	51,379	251,568	2,939	38,909	316,763	530,034	3,138	477	470,701	117,311	14,151	37,597	36,524	83,141	17,094	87,161	4,145
		IC user	48,898	116,096	2,189	31,538	392,064	462,803	2,159	21	380,648	147,968	12,068	46,831	28,356	60,061	12,225	90,848	3,476
		p-value	0.7879	<.0001	0.721	0.3871	0.0244	0.1405	0.7718	0.2866	0.0333	0.0492	0.6365	0.3433	0.3451	0.2081	0.2787	0.8522	0.8118
	Grade 34	HC user	18,966	118,547	1,722	29,630	366,938	230,653	621	124	202,591	56,544	10,952	13,432	37,193	60,402	8,076	75,906	1,675
		IC user	35,060	115,031	2,822	55,318	635,577	335,863	2,994	155	234,148	92,493	18,504	26,706	42,672	48,581	14,779	101,709	559
		p-value	<.0001	0.6353	0.2072	<.0001	<.0001	<.0001	0.0265	0.8373	0.005	<.0001	0.0012	<.0001	0.1886	0.0365	0.0019	<.0001	0.0182
	Grade 5	HC user	13,712	59,326	253	17,299	544,173	173,294	714	132	143,295	40,048	7,556	6,993	17,013	39,226	7,021	66,316	2,287
		IC user	33,029	40,515	3,794	29,262	1,090,014	224,812	82	365	257,725	89,938	13,159	21,101	37,177	17,148	19,716	156,324	1,485
		p-value	0.001	0.0368	0.0402	0.0639	<.0001	0.0669	0.2132	0.4931	<.0001	<.0001	0.2573	0.0111	0.0096	0.0558	0.0441	<.0001	0.6244
Acute hospital service	Sample	HC user	124,084	587,551	15,208	67,445	22,796	138,209	14,939	4,917	464,323	411,445	183,700	23,742	152,366	228,667	59,726	325,744	76,434
		IC user	213,557	395,296	15,727	70,691	46,383	152,372	8,972	2,782	444,961	684,194	252,305	37,141	127,168	295,619	95,161	509,655	56,087
		p-value	<.0001	<.0001	0.8333	0.4358	<.0001	0.0738	<.0001	0.0002	0.1807	<.0001	<.0001	0.0009	0.0007	<.0001	<.0001	<.0001	0.0007
	Grade 12	HC user	214,433	1,137,994	28,324	74,780	26,579	341,718	10,801	2,517	584,701	893,849	257,987	65,178	114,049	379,644	103,320	288,783	162,414
		IC user	266,621	658,099	13,194	93,436	20,423	165,011	5,115	773	429,626	1,071,988	233,745	90,058	63,524	413,654	128,151	220,203	108,366
		p-value	0.0687	<.0001	0.0607	0.2012	0.2396	<.0001	0.0037	0.012	0.001	0.0072	0.3696	0.2805	0.0012	0.3442	0.1878	0.008	0.0693
	Grade 34	HC user	125,507	603,893	15,099	73,633	20,879	130,057	15,711	5,140	477,537	397,048	185,711	21,793	172,693	235,499	57,630	334,414	77,496
		IC user	222,789	408,486	15,781	75,259	44,638	157,873	9,671	3,419	462,718	670,093	272,806	37,166	151,850	304,003	94,691	537,718	58,437
		p-value	<.0001	<.0001	0.8177	0.7489	<.0001	0.0031	<.0001	0.0237	0.3889	<.0001	<.0001	0.0006	0.031	<.0001	<.0001	<.0001	0.0048
	Grade 5	HC user	70,349	203,769	8,435	33,529	30,560	62,935	13,416	5,155	340,458	219,361	132,849	10,549	77,566	113,786	46,401	303,893	26,074
		IC user	163,232	214,678	19,054	41,710	63,871	118,252	8,572	706	387,518	540,750	173,790	16,127	60,526	185,192	80,666	548,457	23,229
		p-value	<.0001	0.7429	0.0888	0.2684	0.0007	0.0009	0.0341	<.0001	0.1803	<.0001	0.0294	0.2154	0.1666	0.0008	0.0117	<.0001	0.7505
Other hospital service	Sample	HC user	14,683	56,744	786	7,693	27,292	70,725	23,585	1,195	73,242	40,021	10,502	4,123	67,771	19,784	4,556	85,455	2,404
		IC user	40,495	50,061	1,405	13,361	143,250	52,388	12,372	1,160	68,351	123,997	16,578	9,573	50,500	49,302	11,313	132,355	1,818
		p-value	<.0001	0.1566	0.0553	<.0001	<.0001	0.0018	<.0001	0.8663	0.4138	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.4767
	Grade 12	HC user	17,602	121,242	619	3,886	19,244	175,876	9,881	539	168,781	52,808	7,865	6,633	27,330	27,668	7,344	61,878	11,548
		IC user	33,617	68,146	720	8,765	57,983	70,172	4,955	103	154,823	154,715	15,015	14,238	20,985	54,265	18,011	59,888	2,543
		p-value	0.0125	0.0005	0.8523	0.0382	0.0006	<.0001	0.0006	0.0214	0.6807	<.0001	0.0297	0.0544	0.4723	0.0047	0.113	0.8396	0.0616
	Grade 34	HC user	14,896	58,100	849	8,125	25,640	68,104	25,256	1,202	70,976	39,838	10,445	4,325	77,413	20,279	4,462	88,409	1,854
		IC user	44,563	51,903	1,587	14,490	137,869	52,388	13,339	1,508	57,505	122,806	17,608	9,735	55,493	52,029	10,999	126,970	2,054
		p-value	<.0001	0.2899	0.0814	<.0001	<.0001	0.0104	<.0001	0.2719	0.0202	<.0001	<.0001	0.0003	<.0001	<.0001	<.0001	<.0001	0.8388
	Grade 5	HC user	12,341	15,786	572	7,767	40,397	24,249	22,933	1,518	32,466	34,433	12,327	1,955	43,470	12,696	3,515	83,261	429
		IC user	26,424	30,308	638	10,381	174,163	29,632	12,702	215	80,701	113,421	14,001	7,025	46,445	31,721	9,184	202,385	79
		p-value	0.0055	0.0835	0.8774	0.3872	<.0001	0.7091	<.0001	<.0001	0.0027	<.0001	0.5923	0.0209	0.6952	0.0009	0.0125	<.0001	0.1238

Treatment 3			Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13	Ch 14	Ch 18	Ch 19	Ch 21
Outpatient service	Sample	HC user	17,131	200,442	7,409	50,033	141,305	80,033	56,762	12,327	113,310	47,258	38,727	20,151	197,560	413,138	38,318	64,892	18,045
		IC user	15,971	71,509	6,869	48,815	201,818	45,290	25,203	5,232	71,408	36,789	28,402	25,067	76,377	127,118	39,256	48,697	5,589
		p-value	0.0707	<.0001	0.7206	0.2856	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004	<.0001	<.0001	0.3417	<.0001	<.0001
	Grade 12	HC user	19,147	298,170	6,444	34,829	75,397	122,757	25,612	6,146	116,237	46,454	33,615	23,574	96,870	364,581	41,275	55,200	24,360
		IC user	15,503	102,714	7,555	43,695	109,296	45,126	11,584	3,887	70,671	36,172	27,608	35,603	43,819	141,894	42,968	36,824	6,236
		p-value	0.0427	<.0001	0.6162	0.0014	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0146	0.0007	<.0001	<.0001	0.5431	<.0001	<.0001
	Grade 34	HC user	17,499	217,075	7,910	52,060	122,702	79,204	60,903	12,936	117,313	47,915	40,252	20,549	215,876	478,454	38,349	66,625	19,250
		IC user	16,295	69,130	7,470	50,570	194,204	46,653	27,569	5,708	74,750	37,855	29,842	24,306	81,807	155,242	39,325	49,374	6,429
		p-value	0.1314	<.0001	0.8227	0.2919	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0282	<.0001	<.0001	0.4202	<.0001	<.0001
	Grade 5	HC user	14,225	67,632	5,449	48,474	264,419	59,726	53,893	12,765	92,726	44,412	34,336	16,472	165,118	129,696	36,518	61,858	8,783
		IC user	17,037	59,757	4,175	43,357	268,278	36,249	23,792	3,375	61,813	32,336	21,769	24,815	71,748	32,315	36,895	53,326	3,072
		p-value	0.1259	0.6128	0.4064	0.0783	0.6543	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0453	<.0001	<.0001	0.8842	0.0093	<.0001
LTCH service	Sample	HC user	21,376	118,818	1,620	28,841	396,531	246,263	908	147	214,393	59,837	10,790	15,026	33,998	57,769	8,688	76,922	1,998
		IC user	38,984	114,362	3,071	51,518	850,774	318,119	939	195	249,606	104,065	19,019	25,336	48,798	49,669	18,706	101,768	555
		p-value	<.0001	0.5822	0.1465	<.0001	<.0001	<.0001	0.9506	0.7837	0.0056	<.0001	0.0011	0.0004	0.0025	0.241	0.0005	0.0007	0.0012
	Grade 12	HC user	49,514	244,652	2,916	36,507	309,844	524,561	2,962	418	455,320	113,144	13,418	35,978	36,169	79,342	15,818	82,869	4,287
		IC user	60,103	105,770	1,510	41,118	432,421	442,945	3,062	-	426,481	178,292	13,894	56,041	24,314	81,194	17,002	107,899	3,029
		p-value	0.3341	<.0001	0.4585	0.6425	0.0016	0.0913	0.977	0.2608	0.5341	0.0005	0.9238	0.0862	0.2003	0.932	0.816	0.3123	0.6382
	Grade 34	HC user	19,651	117,320	1,732	30,334	372,046	231,849	762	115	202,635	57,639	11,202	14,250	37,180	59,539	8,229	77,033	1,672
		IC user	37,751	137,539	3,855	59,348	736,901	312,683	1,007	239	226,436	100,388	17,172	22,863	49,783	48,668	17,541	100,620	33
		p-value	<.0001	0.0584	0.1133	<.0001	<.0001	<.0001	0.6506	0.5748	0.0949	<.0001	0.0328	0.0057	0.0412	0.1553	0.0068	0.0068	<.0001
	Grade 5	HC user	15,210	58,577	541	18,084	557,473	173,334	678	157	148,817	43,087	7,339	8,028	17,354	37,352	7,493	73,968	2,350
		IC user	24,397	27,387	-	23,086	1,556,637	299,813	-	-	254,547	94,426	26,203	20,707	63,103	30,965	22,872	103,218	1,052
		p-value	0.2293	0.0085	0.0051	0.5355	<.0001	0.0313	0.1517	0.1907	0.009	0.0108	0.0879	0.138	0.0042	0.7794	0.1382	0.1561	0.3603
Acute hospital service	Sample	HC user	131,058	579,106	15,424	68,435	24,357	139,650	14,682	4,868	470,592	433,197	188,590	24,904	152,299	234,746	61,227	342,832	75,669
		IC user	204,997	396,599	12,602	59,315	47,454	123,853	8,574	1,937	359,554	694,892	218,009	41,411	129,168	314,786	109,649	407,979	56,868
		p-value	<.0001	<.0001	0.2735	0.0649	<.0001	0.0903	<.0001	0.0001	<.0001	<.0001	0.0081	0.0019	0.0284	<.0001	<.0001	<.0001	0.0089
	Grade 12	HC user	223,265	1,112,874	27,420	76,809	27,273	334,240	10,696	2,476	582,650	913,785	257,338	69,657	113,177	387,013	103,224	293,301	158,937
		IC user	260,556	616,943	14,923	91,397	17,335	153,722	4,254	486	416,499	1,104,732	230,043	92,600	54,797	408,329	120,492	209,475	43,125
		p-value	0.2126	<.0001	0.1253	0.3531	0.0657	<.0001	0.0025	0.0019	0.0021	0.0086	0.3258	0.4237	0.0003	0.5817	0.3809	0.0015	<.0001
	Grade 34	HC user	132,911	595,850	15,505	74,689	22,226	132,199	15,423	5,125	484,917	418,638	191,492	22,933	173,007	242,096	59,397	352,207	76,826
		IC user	199,045	400,978	11,480	58,493	48,303	115,027	9,794	2,291	352,201	679,342	235,124	41,607	144,577	330,925	108,466	429,748	71,079
		p-value	<.0001	<.0001	0.1741	0.0068	<.0001	0.0988	<.0001	0.0044	<.0001	<.0001	0.002	0.0016	0.0351	<.0001	<.0001	<.0001	0.5468
	Grade 5	HC user	74,538	204,889	8,645	33,873	33,510	65,854	13,244	4,949	346,004	244,002	136,866	10,662	76,242	118,252	47,394	324,865	26,120
		IC user	222,268	243,981	20,466	39,872	53,374	126,359	6,414	406	382,516	580,750	138,302	23,590	78,489	171,222	119,278	404,586	22,534
		p-value	0.0024	0.452	0.2567	0.4463	0.1115	0.0539	0.0139	<.0001	0.4969	<.0001	0.9484	0.1289	0.9267	0.0873	0.0413	0.0811	0.8163
Other hospital service	Sample	HC user	16,249	55,957	794	8,214	31,098	70,087	23,035	1,200	72,845	46,158	11,061	4,517	67,098	21,564	4,958	89,601	2,340
		IC user	40,947	44,067	1,883	10,872	172,966	43,178	12,506	439	72,677	114,465	18,138	7,365	46,537	50,452	12,411	105,438	2,456
		p-value	<.0001	0.0422	0.0254	0.0539	<.0001	0.0005	<.0001	<.0001	0.9821	<.0001	<.0001	0.0485	<.0001	<.0001	<.0001	0.0061	0.9278
	Grade 12	HC user	18,907	114,789	613	4,771	19,038	171,049	9,577	519	166,320	63,147	8,740	8,434	27,542	28,704	8,149	64,735	10,907
		IC user	32,291	83,137	720	6,898	77,313	78,408	4,589	22	178,059	153,374	15,780	7,209	21,365	63,606	21,081	54,042	2,179
		p-value	0.0702	0.0568	0.868	0.3344	0.0001	0.0002	0.0007	0.0014	0.7718	<.0001	0.0748	0.7272	0.5686	0.0019	0.1348	0.2974	0.0583
	Grade 34	HC user	16,482	57,758	863	8,696	29,369	68,029	24,667	1,229	70,648	45,592	11,017	4,569	76,709	22,273	4,817	92,038	1,822
		IC user	46,108	41,061	2,279	8,948	167,627	34,202	13,793	464	52,552	113,536	19,455	8,082	43,544	53,607	13,595	104,361	2,993
		p-value	<.0001	0.0192	0.0335	0.8542	<.0001	<.0001	<.0001	<.0001	0.0077	<.0001	<.0001	0.0483	<.0001	<.0001	<.0001	0.0481	0.4882
	Grade 5	HC user	13,835	16,199	559	7,834	46,270	24,159	22,416	1,437	33,809	40,173	12,635	2,303	42,756	14,068	3,994	90,783	430
		IC user	17,869	21,374	1,540	18,637	208,690	25,901	11,884	459	127,805	95,195	16,889	5,466	81,278	26,279	4,463	162,464	-
		p-value	0.5037	0.6468	0.3649	0.1257	<.0001	0.9392	0.0007	0.0058	0.0007	0.0045	0.3261	0.3164	0.0209	0.0841	0.7954	0.0136	0.0241

* Treatment variable is place of receiving long-term care (LTC), categorized as institutional care (IC) user (=1) or home and community base care (HC) user (=0).
* Treatment 1: Subjects who are switch users (used both services within follow-up period) were removed
* Treatment 2: Subjects who are switch users (used both services within follow-up period) were treated as HC group
* Treatment 3: Subjects who are switch users (used both services within follow-up period) were treated as IC group

* Diseases were categorized as follows, in accordance with ICD-10 chapters. Chapter 15, 16, 17, 20, and 22 were not suggested as they have negligible proportion among the sample.

Infectious & Parasitic (Chapter 1. A00-B99)	Neoplasm (Chapter 2. C00-D48)
Bolld & Immune (Chapter 3. D50-D89)	Endocrine & Metabolic (Chapter 4. E00-E90)
Mental & Behavioral (Chapter 5. F00-F99)	Nervous (Chapter 6. G00-G99)
Eye & adnexa (Chapter 7. H00-H59)	Ear & mastoid process (Chapter 8. H60-H95)
Circulatory (Chapter 9. I00-I99)	Respiratory (Chapter 10. J00-J99)
Digestive (Chapter 11. K00-K93)	Skin & subcutaneous (Chapter 12. L00-L99)
Muskuloskeletal (Chapter 13. M00-M99)	Genitourinary (Chapter 14. N00-N99)
Pregnancy & birth (Chapter 15. O00-O99)	Perinatal (Chapter 16. P00-P96)
Congenital (Chapter 17. Q00-Q99)	Not elsewhere classified (Chapter 18. R00-R99)
Injury & external (Chapter 19. S00-T98)	External morbidity/mortality (Chapter 20. V01-Y98)
Palliative & rehabillatative (Chapter 21. Z00-Z99)	Specific purposes (Chapter 22. U00-U99)

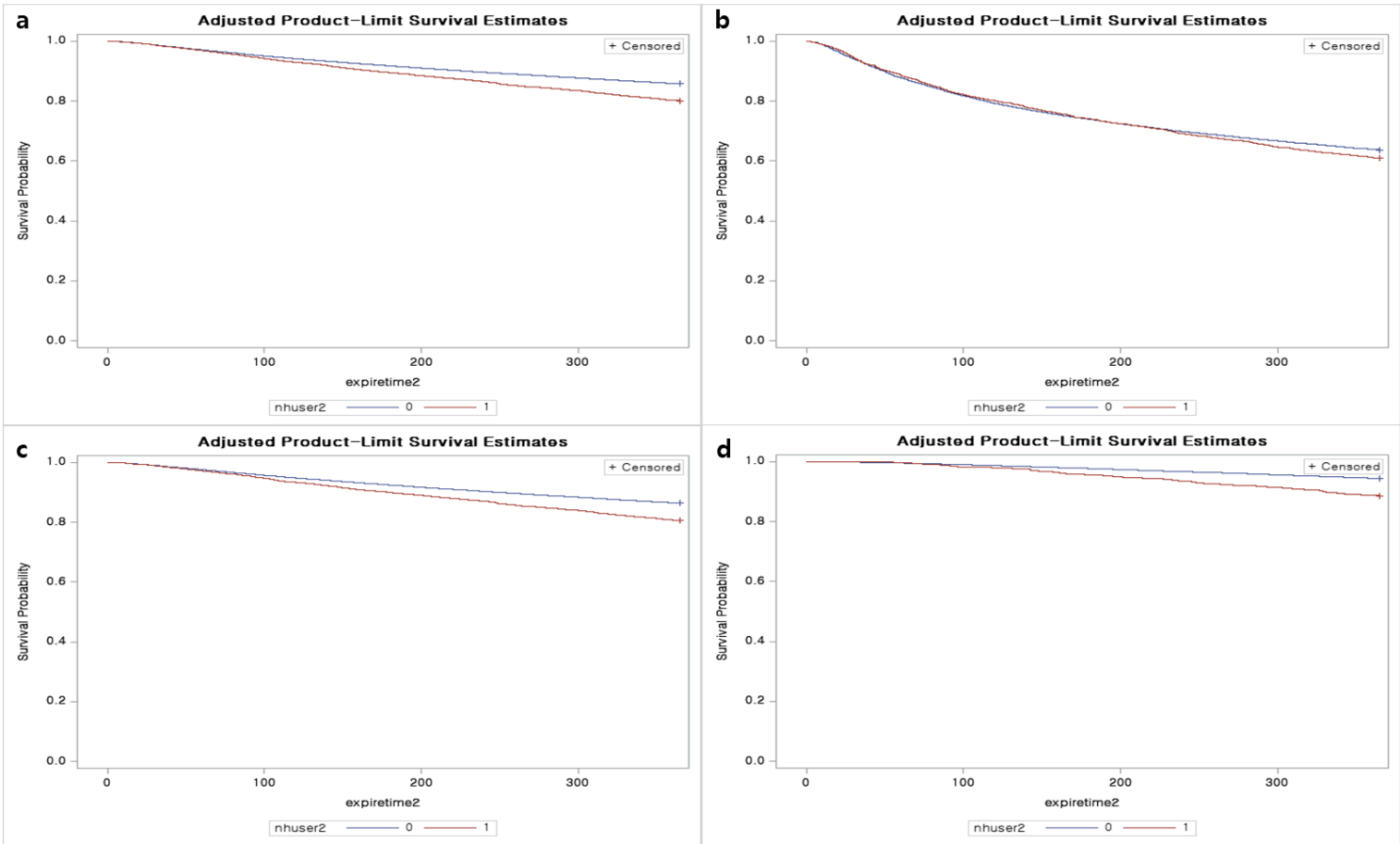
[Appendix 5.9] Comparison of medical utilization by primary causes (ICD-10 chapters), additionally adjusting baseline utilization due to ICD-10 major disease chapter which has shown largest difference in main analysis.

			Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13	Ch 14	Ch 18	Ch 19	Ch 21
Outpatient service	Sample	HC user	17,088	203,867	7,457	49,985	137,082	81,236	58,890	12,685	114,759	47,593	39,363	19,883	204,814	433,724	37,905	64,456	18,646
		IC user	15,872	87,611	6,875	47,945	183,829	45,959	25,516	5,355	72,107	36,686	28,131	24,805	76,993	260,644	38,865	48,766	5,222
		p-value	0.0622	<.0001	0.7171	0.0723	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0004	<.0001	<.0001	0.3349	<.0001	<.0001
	Grade 12	HC user	19,173	303,995	6,263	34,160	71,818	126,136	26,157	6,048	116,198	46,715	33,839	23,249	98,611	380,055	40,635	54,903	25,422
		IC user	14,806	133,248	7,761	42,415	97,952	43,638	10,866	3,950	68,652	35,369	28,176	36,147	42,011	311,417	41,082	43,238	4,968
		p-value	0.0198	<.0001	0.5256	0.0032	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0291	0.0004	<.0001	0.1068	0.8729	0.0043	<.0001
	Grade 34	HC user	17,465	222,555	8,006	52,059	118,000	80,237	63,172	13,329	118,866	48,261	40,956	20,271	223,673	503,878	37,910	66,245	19,898
		IC user	16,383	82,937	7,315	49,844	174,048	47,883	28,107	5,866	75,661	37,713	29,256	23,964	83,645	306,641	39,192	48,954	5,996
		p-value	0.1832	<.0001	0.7393	0.115	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0289	<.0001	<.0001	0.2983	<.0001	<.0001
	Grade 5	HC user	13,946	67,036	5,320	47,946	262,909	59,472	55,313	13,006	93,443	44,170	34,442	16,017	168,182	129,850	36,008	60,422	8,908
		IC user	15,261	90,894	5,137	44,702	259,971	40,572	24,065	3,898	60,027	31,919	22,375	23,012	71,347	31,507	35,774	52,239	3,223
		p-value	0.4374	0.2113	0.9118	0.2605	0.7243	0.0002	<.0001	<.0001	<.0001	<.0001	<.0001	0.0521	<.0001	<.0001	0.9256	0.009	<.0001
LTCH service	Sample	HC user	20,773	120,037	1,570	28,504	394,295	247,501	832	150	214,299	58,761	10,738	14,343	34,420	59,978	8,630	75,313	1,985
		IC user	38,488	148,568	3,088	53,363	791,380	340,310	1,060	140	273,022	101,794	19,187	24,293	51,326	74,511	20,409	107,375	498
		p-value	<.0001	0.002	0.1506	<.0001	<.0001	<.0001	0.6659	0.9333	<.0001	<.0001	0.0009	0.0005	0.0008	0.0807	<.0001	<.0001	0.0004
	Grade 12	HC user	52,090	248,822	2,917	38,810	329,195	538,114	3,258	447	471,221	118,218	14,231	37,980	37,647	83,356	17,162	87,601	4,082
		IC user	57,150	133,611	1,438	37,069	396,709	442,139	2,768	-	429,860	169,870	13,253	54,455	22,996	135,645	20,731	104,831	2,583
		p-value	0.6412	<.0001	0.4603	0.8595	0.0774	0.053	0.8924	0.2793	0.3859	0.005	0.8461	0.1582	0.1147	0.0525	0.5212	0.4856	0.5564
	Grade 34	HC user	18,900	118,701	1,732	29,763	369,462	232,190	629	123	201,957	56,432	10,967	13,389	37,531	61,526	8,120	75,922	1,690
		IC user	38,404	180,627	3,906	62,414	665,859	337,059	1,165	169	242,463	99,569	17,571	22,247	51,271	70,029	18,673	106,229	25
		p-value	<.0001	<.0001	0.1279	<.0001	<.0001	<.0001	0.3465	0.7511	0.006	<.0001	0.0236	0.0042	0.0317	0.3497	0.0036	0.0008	<.0001
	Grade 5	HC user	13,904	59,017	259	17,382	553,587	172,786	710	132	143,641	40,068	7,714	6,940	17,130	38,357	7,111	66,343	2,293
		IC user	20,992	41,242	-	21,158	1,547,891	328,349	-	-	318,248	75,126	30,070	19,226	86,752	28,702	22,843	131,823	916
		p-value	0.3145	0.2044	0.0186	0.6198	<.0001	0.0097	0.1583	0.2858	0.0001	0.0311	0.0389	0.1454	0.0002	0.667	0.1249	0.0061	0.3248
Acute hospital service	Sample	HC user	124,885	587,595	15,312	68,064	23,646	140,742	15,071	4,986	467,423	414,018	185,093	24,050	155,972	232,483	60,135	328,242	77,009
		IC user	205,785	535,809	13,178	60,385	40,332	129,097	9,017	1,776	373,912	672,743	222,724	42,248	145,917	370,853	114,539	430,809	70,285
		p-value	<.0001	0.1605	0.4383	0.1318	<.0001	0.2155	<.0001	<.0001	<.0001	<.0001	0.0012	0.0008	0.3841	<.0001	<.0001	<.0001	0.4006
	Grade 12	HC user	217,284	1,127,442	28,449	75,553	28,098	353,638	10,862	2,511	592,586	911,192	261,189	66,504	115,634	385,841	105,271	291,456	162,341
		IC user	266,206	817,596	15,342	90,456	15,323	146,066	5,959	481	430,314	1,054,160	248,454	95,219	54,266	424,505	115,338	199,531	57,674
		p-value	0.1135	0.0041	0.1329	0.3484	0.0202	<.0001	0.0433	0.0029	0.0034	0.0503	0.6704	0.3274	0.0002	0.3259	0.6078	0.0006	<.0001
	Grade 34	HC user	126,228	609,343	15,282	74,406	21,705	131,973	15,865	5,207	480,388	398,913	187,281	22,066	176,775	240,193	57,999	336,993	78,563
		IC user	196,188	543,958	12,167	60,457	39,326	119,959	10,455	2,029	368,523	673,705	239,375	42,223	162,604	406,261	115,501	458,029	85,550
		p-value	<.0001	0.1417	0.3406	0.0248	<.0001	0.2429	0.0003	0.0002	<.0001	<.0001	0.0004	0.0008	0.3325	<.0001	<.0001	<.0001	0.5055
	Grade 5	HC user	70,228	201,164	8,346	32,854	31,356	63,032	13,340	5,160	339,535	218,864	132,218	10,482	76,962	112,697	46,361	304,102	25,890
		IC user	238,666	276,423	16,625	42,041	54,560	151,799	5,395	518	397,427	486,536	133,781	24,790	138,478	228,885	118,573	468,232	31,435
		p-value	0.0019	0.158	0.3128	0.2701	0.0602	0.0117	0.0017	<.0001	0.3051	<.0001	0.9427	0.1106	0.0972	0.0035	0.0215	0.0014	0.773
Other hospital service	Sample	HC user	14,728	56,591	791	7,740	28,438	72,237	23,785	1,201	74,335	40,093	10,574	4,150	69,114	20,235	4,569	86,182	2,427
		IC user	41,174	56,192	2,030	11,070	145,015	36,680	12,927	462	77,214	111,764	17,170	7,632	46,752	60,695	11,733	108,662	2,531
		p-value	<.0001	0.9534	0.02	0.0197	<.0001	<.0001	<.0001	<.0001	0.7143	<.0001	<.0001	0.0161	<.0001	<.0001	<.0001	0.0002	0.9364
	Grade 12	HC user	17,616	119,190	602	3,980	20,703	182,382	9,983	529	174,709	53,579	7,756	6,707	27,768	28,482	7,378	62,631	11,730
		IC user	32,211	101,096	742	6,517	68,333	71,574	4,260	23	171,962	148,638	15,039	7,185	18,857	66,792	19,274	53,615	1,935
		p-value	0.0534	0.3042	0.8326	0.2299	0.0012	<.0001	0.0001	0.0022	0.946	<.0001	0.061	0.8919	0.377	0.0009	0.1562	0.3915	0.0484
	Grade 34	HC user	14,894	58,437	851	8,158	26,763	69,450	25,442	1,208	71,868	39,810	10,518	4,336	78,856	20,815	4,464	89,162	1,873
		IC user	45,282	54,685	2,509	9,145	140,886	35,192	14,555	500	55,184	107,139	19,049	8,458	44,626	66,240	12,664	107,301	3,172
		p-value	<.0001	0.6638	0.0239	0.4848	<.0001	<.0001	<.0001	0.0004	0.0189	<.0001	<.0001	0.0205	<.0001	<.0001	<.0001	0.0047	0.4514
	Grade 5	HC user	12,326	15,713	586	7,659	41,639	24,418	22,916	1,513	32,309	34,381	12,367	1,933	43,392	12,613	3,542	83,154	435
		IC user	24,582	19,228	1,044	22,385	197,684	30,673	11,271	468	131,271	98,916	11,782	4,971	77,314	33,085	4,724	159,255	-
		p-value	0.1217	0.7049	0.6038	0.0655	<.0001	0.819	0.0001	0.0039	0.0002	0.0014	0.8797	0.3236	0.0456	0.0101	0.4886	0.0145	0.0312

* Diseases were categorized as follows, in accordance with ICD-10 chapters. Chapter 15, 16, 17, 20, and 22 were not suggested as they have negligible proportion among the sample.

Infectious & Parasitic (Chapter 1. A00-B99)	Neoplasm (Chapter 2. C00-D48)
Bolld & Immune (Chapter 3. D50-D89)	Endocrine & Metabolic (Chapter 4. E00-E90)
Mental & Behavioral (Chapter 5. F00-F99)	Nervous (Chapter 6. G00-G99)
Eye & adnexa (Chapter 7. H00-H59)	Ear & mastoid process (Chapter 8. H60-H95)
Circulatory (Chapter 9. I00-I99)	Respiratory (Chapter 10. J00-J99)
Digestive (Chapter 11. K00-K93)	Skin & subcutaneous (Chapter 12. L00-L99)
Muskuloskeletal (Chapter 13. M00-M99)	Genitourinary (Chapter 14. N00-N99)
Pregnancy & birth (Chapter 15. O00-O99)	Perinatal (Chapter 16. P00-P96)
Congenital (Chapter 17. Q00-Q99)	Not elsewhere classified (Chapter 18. R00-R99)
Injury & external (Chapter 19. S00-T98)	External morbidity/mortality (Chapter 20. V01-Y98)
Palliative & rehabillatative (Chapter 21. Z00-Z99)	Specific purposes (Chapter 22. U00-U99)

[Appendix 5.10] Kaplan-Meier survival curve and results of survival analysis on mortality, stratified by LTC place



* Panel a-d are entropy balancing weight adjusted Kaplan-Meier survival curves using time-to-death, each representing whole sample, grade 1-2 sample, grade 3-4 sample, and grade 5 sample respectively.
* Treatment 2 condition (subjects who used both services within follow-up period were treated as HC users (home and community based care user)) was applied.
* Blue line (nhuser2=0) indicates the entropy balancing weight adjusted Kaplan-Meier survival curves of the HC users, while the red line (nhuser2=1) indicates the entropy balancing weight adjusted Kaplan-Meier survival curves of the IC users (institutional care users).
* In order to compare the total area under the Kaplan-Meier survival curves between HC users and IC users, restricted mean survival time (RMST) was additionally calculated, and had shown that mean survival time is longer among HC users compared to IC users among all subgroups (Whole sample: 336.0 vs 327.2; Grade 1-2 sample: 278.5 vs 277.2; Grade 3-4 sample: 338.2 vs 329.3; Grade 5 sample: 356.0 vs 348.1, in days)

국문초록

장기요양 탈시설화가 건강 및 비용에 미치는 영향

서울대학교 보건대학원
보건학과 보건정책관리학 전공
윤 성 훈

이 연구는 두 가지 중요한 연구 주제를 조사하는 것을 목표로 한다. 첫째, 장기요양 탈시설화가 건강과 비용에 미치는 영향이 수급자의 초기 건강 상태에 따라 달라지는지 분석하였다. 한국을 포함한 많은 국가에서 건강을 장기요양급여 지급의 중요한 기준으로 삼고 있고 건강이 장기요양정책의 중요한 성과 중 하나라는 점을 고려할 때, 건강 수준에 따라 탈시설화의 영향이 달라지는지 살펴보는 것은 중요한 함의를 지닌다. 그러나 많은 국가에서 장기요양 서비스 이용 대상을 중증도가 높은 노인으로 제한하고 있음에도 불구하고, 건강 상태에 따라 탈시설화의 효과가 달라질 수 있는지 실증적으로 조사한 연구는 드물었다. 한국의 제도가 상대적으로 경증인 노인도 시설 서비스를 이용할 수 있도록 허용하고 있다는 점은 제도의 효과성이나 효율성 관점에서는 의문을 제기할 수 있는 측면이 있지만, 중증도에 따라 탈시설화의 효과가 달라지는지 분석할 수 있다는 측면에서는 장점이 있다. 본 연구는 한국의 사례를 통해 중증자에 비해 경증자의 경우에서

탈시설화의 편익이 비용과 건강 측면에서 더 클 수 있음을 실증적으로 보여주었다. 둘째, 이 연구는 장기요양 탈시설화가 건강과 비용에 미치는 영향의 기저에 있는 근본적인 경로를 탐구했다. 이와 같은 분석은 건강한 노화에 대한 공중보건 프레임워크를 차용하여 노인의 건강 결과에 영향을 미치는 주요 실행 가능한 차원인 의료 이용, 장기요양 이용, 환경이 장기요양 탈시설화에 따라 다르게 영향을 받을 수 있다고 가정하는 것에서 출발했다. 본 연구에서는 예방 가능한 입원과 응급실 방문을 의료 이용의 대리 변수로, 우울증으로 인한 약물 사용과 낙상으로 인한 입원을 각각 심리사회적 환경과 물리적 환경의 대리 변수로 삼아 이러한 경로를 실증적으로 탐색했다. 또한, 장기요양 탈시설화가 의료 이용 패턴에 미치는 영향은 건강 결과와 비용 모두에 영향을 미치는 가장 주요한 요인인 점을 고려하여 보다 심층적인 분석을 수행했다.

본 연구는 2015~2017년 신규로 장기요양 급여 수급자격을 취득한 전 국민에 대한 국민건강보험과 장기요양보험 자료를 활용하여 분석을 수행함에 따라, 국가 전체에서의 영향을 조망할 수 있었다. 본 연구에서는 두 가지 중요한 방법론적 고려 사항이 존재한다. 첫째, 장기요양 탈시설화에 대한 결정은 무작위로 이루어지지 않기 때문에, 교란을 발생시킬 수 있는 변수들이 충분히 조절되지 못할 경우 편향된 분석 결과가 도출될 수 있다. 본 연구에서는 처치군과 대조군에 대한 무작위 배정을 빌려올 수 있는 적절한 도구변수를 찾지 못했지만, 국민건강보험공단의 풍부한 데이터를 활용하여 소득 수준, 비공식 간병 자원 또는 이전 의료 활용 패턴과 같은 청구 데이터에서 흔히 사용할 수 없는 변수들의 영향을 통제할 수 있었다. 본 연구에서는 통제변수의 평균과 분산을 동일한 수준으로 일치시키는 Entropy Balancing Weight를 도출하고, 가중 최소제곱 회귀분석(weighted least square regression)을 통해 재가 서비스와 비교한 시설 서비스의 평균 처치 효과(average treatment effect)를 추정하였다. 둘째, 장기요양 서비스를 제공받는 장소는 시간이 지남에 따라 달라질 수 있다. 비록 연구 표본

중 이와 같은 교차이용자의 비율은 적었지만(1년 추적 관찰 기간 동안 장기 치료를 받는 장소를 변경한), 교차이용에 대한 결정이 기존의 서비스 이용 장소와 기타 교란을 일으킬 수 있는 변수 모두에 의해 영향을 받을 수 있음에 따라 교차이용자를 단순히 연구대상자에서 제거하는 것은 편향된 결과로 이어질 수 있다. 본 연구에서는 결과의 견고성을 확인하기 위해 이들 교차이용자들을 몇 가지 다른 방법(교차이용자 제외, 교차 이용자를 모두 처치군 혹은 대조군에 배정)으로 배정한 민감도 분석을 수행하였다.

연구 결과, 장기요양 탈시설화가 일반적으로 건강 및 공적 서비스 비용 측면 모두에서 유익한 것으로 나타났으며, 다만 이러한 효과의 크기는 수혜자의 초기 건강상태가 악화됨에 따라 감소하는 것으로 밝혀졌다. 사망, ADL(activities of daily living), IADL(instrumental activities of daily living), 인지수준 등 다양한 척도에서 장기요양 시설 입소가 재가 서비스 이용 시에 비해 건강결과에 미치는 부정적인 영향은 일관되게 나타났다. 공적 서비스 비용과 관련하여, 장기요양 서비스 비용(장기요양보험 청구자료를 이용하여 측정함)과 의료비(국민건강보험 청구자료를 이용하여 측정함)는 다른 추세를 보였다. 장기요양 서비스 비용은 수혜자의 초기 건강상태와 관계없이 재가 서비스 이용자에 비해 시설 서비스 이용자에서 더 높게 나타났다. 그러나 가장 중증도가 높은 이용자들에서는(1-2등급) 시설 서비스 이용자에서 재가 서비스 이용자에 비해 더 적은 의료비가 발생하였고, 다만 이 같은 결과는 중증도가 낮은 이용자들에서는(3-4, 5등급) 반대로 나타났다. 종합적으로 볼 때, 장기요양 서비스 비용 및 의료비를 포함한 전체 공적 서비스 비용은 시설 서비스 이용자들에서 더 높게 나타났으며, 다만 이러한 영향의 규모는 수혜자의 초기 건강상태가 악화됨에 따라 감소하였다. 이러한 결과는 장기요양 탈시설화가 중증도가 낮은 사람에서 더 유익할 수 있음을 보여주며, 시설 서비스 이용자의 3분의 2가 중증도가 낮은 3-5 등급 인정자인 한국의 맥락에서 장기요양 서비스 이용의 분배적 효율성에 문제가 있을 수 있음을 시사한다.

본 연구는 또한 장기요양 탈시설화가 건강과 비용에 미치는 영향을 설명하는 경로를 실증분석을 통해 보여주었다는 측면에서 그 의의가 있다. 본 연구에서는 장기요양 탈시설화는 단순히 장기요양 서비스의 한 유형으로 볼 수 없고 기존의 사회적, 물리적 연결로부터 소외시키는 이주이며, 이에 따라 장기요양 탈시설화는 건강한 노화와 관련된 다양한 영역들에 모두 영향을 미칠 수 있음을 주장하였다. 이와 같은 가정이 실제로 성립하는지 실증분석을 통해 살펴보기 위해, 몇 가지 변수들이 활용되었다. 본 연구에서는 시설 서비스 이용자에서 예방 가능한 입원 및 부적절한 응급실 방문을 경험할 위험, 우울증으로 인한 의료이용 위험, 고관절 골절로 인한 입원 위험이 모두 더 높은 것으로 나타났으며, 이들은 각각 보건의료 서비스 이용, 사회적 환경, 그리고 물리적 환경을 대표하는 변수로 활용되었다. 또한 의료이용은 건강 성과와 비용 모두에 영향을 미치는 핵심 개념 중 하나인 점을 고려하여, 장기요양 탈시설화가 의료이용에 미치는 영향을 보다 심도 있게 분석되었다.

본 연구에서 주목할 만한 결과 중 하나는 장기요양 탈시설화가 의료이용에 미치는 전체적인 영향(total effect)을 의료이용 패턴에 미치는 직접적인 영향(direct effect)과 건강상태 변화에 의한 간접적인 영향(indirect effect)의 두 가지 개념적인 측면으로 구분하였다는 것이다. 건강상태 변화를 통한 간접적인 영향(indirect effect)은 건강변화에 종속되는 단순한 결과로 간주될 수 있지만, 의료이용 패턴에 대한 직접적인 영향(direct effect)은 장기요양 탈시설화가 건강과 비용 모두에 어떻게 영향을 미칠 수 있는지에 대한 경로를 설명할 수 있다. 본 연구에서는 연구 결과의 논리적 해석을 통해 장기요양 탈시설화가 의료 이용 패턴에 부정적인 직접적 영향을 미칠 수 있음을 제시하였다. 연구 결과에 따르면 장기요양기관화는 의료이용에 대해 부정적인 전체적인 영향(total effect)을 미칠 수 있으며, 특히 외래서비스와 중증도가 가장 높은 군의 입원서비스에 있어 이와 같은 경향이 나타났다. 장기요양 시설 입소가 건강결과에 부정적인 영향을 미친다는 점을 고려할 때, 장기요양 시설 입소는 수급자의 건강상태를 악화로 인해

의료이용이 증가되는 간접적인 영향(indirect effect)을 보일 것이라고 가정할 수 있다. 이와 같은 맥락에서, 의료이용에 대한 전체적인 영향(total effect)이 음(-)의 효과를 지닌다는 것은 건강상태 변화를 통한 간접효과(indirect effect)는 양(+)의 값을 가진다는 점을 고려할 때 (장기요양 시설 입소가 의료이용에 미치는) 직접효과(direct effect)는 음(-)의 효과를 지니는 것으로 논리적 분석이 가능하다. 부정적 직접 효과가 존재한다는 결과는 직접 효과와 간접 효과를 정량적으로 분해한 인과 매개 분석 결과에서도 동일하게 나타났으나, 해당 분석의 경우 방법론적 제한점을 고려한 주의 깊은 해석이 필요하다. 이와 같은 결과들은 두 가지 측면으로 해석될 수 있다. 장기요양 탈시설화가 예방 가능한 입원의 위험을 증가시킨다는 결과가 시사하는 바와 같이, 이러한 부정적인 직접 효과는 시설 서비스 이용자들의 미충족 의료로 이어져 건강을 악화시킬 수 있다. 반면, 장기요양 탈시설화가 요양병원과 생애말기의 급성병원 입원이용 감소시킬 수 있다는 결과가 시사하는 바와 같이, 이와 같은 영향은 효과가 낮고 비용이 많이 발생하는 서비스 이용을 대체함으로써 효율성 향상으로 이어질 수 있다. 본 연구는 의료 이용 패턴에 대한 이러한 부정적인 직접 효과가 중증자와 상대적으로 중증도가 낮은 이들에게 각기 다른 결과를 야기할 수 있음을 시사한다. 의학적 예방과 질병의 관리의 필요성이 높은 상대적으로 중증도가 낮은 이들의 경우, 의료 이용에 대한 부정적인 직접 효과는 미충족 의료로 이어질 가능성이 높다. 의학적 예방과 질병의 관리보다는 존엄한 삶을 돌보는 것에 대한 수요가 높은 중증자의 경우, 의료 이용에 대한 부정적인 직접 효과는 효율성 향상으로 이어질 가능성이 높다.

마지막으로, 본 연구에서는 건강보험 서비스 이용에 따른 비용을 서비스 유형(외래, 요양병원 입원, 급성기 병원 입원, 기타 병원 입원)과 서비스 이용의 주요 진단 그룹에 따라 세분화한 분석을 통해 장기요양시설 입소가 의료 이용에 미치는 부정적인 직접 효과가 어디에서 기인하는지 조사하였다. 그 결과, 장기요양 시설에 입소하는 것은 만성 신장 질환이나 신체 기능과 관련된 의료 이용에 대한 미충족

의료를 늘리는 반면, 암에 대한 관리에 대해서는 효율성 증진으로 이어질 잠재력이 있는 것으로 나타났다.

본 연구의 결과는 일반적으로 장기요양 탈시설화가 보건의료 시스템의 관점에서 유익하다고 볼 수 있음을 시사한다. 동시에, 중증도가 높은 이들을 대상으로는 장기요양 시설 이용에 따른 장점이 있을 수도 있음을 보여준다. 이와 같은 연구 결과들은 장기요양 대상자의 욕구에 부합하는 장기요양 서비스 공급과 이용이 이루어질 수 있도록 재조정하는 것은 장기요양 시스템의 배분적 효율성을 개선할 수 있는 중요한 정책 방향임을 시사한다.

주제어: 장기요양, 장기요양 탈시설화, 의료이용, 건강, 비용
학번: 2019-36566