Effects of Living Alone and Sedentary Behavior on Quality of Life in Patients With Multimorbidities: A Secondary Analysis of Cross-Sectional Survey Data Obtained From the National Community Database

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Introduction

Quality of life has been a topic of concern for many nursing researchers in recent decades. To help patients achieve a better quality of life, it is critical to identify the related factors. Although the body of literature addressing the issue of quality of life in patients with diseases has grown greatly, more research into the factors that affect quality of life in this population is required (Shofany, 2017).

Multimorbidity means having two or more chronic conditions, which include both physical and mental health problems. The prevalence of multimorbidity has been reported to broadly range from 17.1% to 72.7%. Furthermore, this prevalence appears to increase with age (Low et al., 2019; Prazeres & Santiago, 2015) and to have been on the rise for a long time (King et al., 2018; van Oostrom et al., 2016). Having multimorbidities may increase the likelihood of other health problems (Low et al., 2019; Palladino et al., 2019), which may reduce quality of life and increase mortality (McDaid et al., 2013; Nunes et al., 2016). The number of patients who have multiple chronic conditions is expected to continue to grow because of population aging. Thus, more attention should be paid by healthcare providers to patients with multimorbidities.

Having multimorbidities has been reported in a number of studies to reduce quality of life (Heyworth et al., 2009; Makovski et al., 2019), with higher numbers of concomitant chronic conditions associated with more significant decreases in quality of life (Rothrock et al., 2010; Tyack et al., 2018). Studies on quality of life in chronically ill patients have been conducted regularly. Chronic diseases such

Key Words: living arrangement, multimorbidity, quality of life, sedentary behavior.
as cardiovascular disease, respiratory disease, and diabetes are known to affect disability, self-rated health, and quality of life. Moreover, the risks of these negative health outcomes have been shown to increase with the level of multimorbidity (McDaid et al., 2013). As chronic disease treatment strategies currently focus more on management than on achieving a cure, it is important to improve quality of life by understanding its diverse aspects. Therefore, it is necessary to identify the factors that affect health-related quality of life in patients with multiple chronic conditions.

According to the Census of Population and Housing of South Korea, the proportion of single households has increased steadily in recent years, from 23.9% in 2010 to 30.2% in 2019 (Statistics Korea, 2020). Living arrangement has been identified in several studies as a factor influencing quality of life. Sun et al. (2011), using the European Quality of Life-5 Dimensions (EQ-5D) questionnaire, found living alone to be a predictor of poor mobility, pain/discomfort, and anxiety/depression in elderly individuals. Similarly, Lin et al. (2008) found that elderly people living alone reported a poorer quality of life than the general adult population. Although many research studies have examined the subject of living arrangements, most have focused on older populations. Moreover, little research has focused on the effects of living arrangement on people with multimorbidities.

A sedentary lifestyle is widely known to increase the all-cause mortality hazard ratio independent of physical activity (van der Ploeg et al., 2012). Sedentary behavior has also been shown to affect metabolic function negatively, reduce bone mineral density, and increase vascular problems, each of which has been linked to multiple health problems (Tremblay et al., 2010). In one study of sedentary behavior and quality of life, sedentary behavior was found to affect the physical dimensions of quality of life in cancer survivors (George et al., 2014). However, few studies have examined the impact of living a sedentary lifestyle on quality of life in patients with multimorbidities.

Socioeconomic factors such as age, gender, and employment status have consistently been reported to be associated with quality of life in patients with multimorbidities (Brettschneider et al., 2013; Millá-Perseguer et al., 2019). However, living alone and sedentary behavior are two factors that have been rarely examined. Therefore, this study was developed to identify the effects of living alone and of sedentary behavior on the health-related quality of life of adult patients with multiple chronic conditions in all age groups. Moreover, by utilizing nationally representative population-based data, the authors of this study intend to provide more-generalizable findings that explain the associated factors to help patients with multimorbidities achieve a better quality of life.

**Methods**

**Study Population and Sample**

This study employed a secondary analysis of the 2017 Korea National Health and Nutrition Examination Survey (KNHANES), which included the second year data of the seventh KNHANES (KNHANES VII-2). The KNHANES, which began in 1998, is a community-based national database. The data are collected and managed by the Korea Ministry of Health and Welfare. The KNHANES VII-2 includes nationally representative data on 8,127 people and covers the following three main sections: health survey, physical and laboratory tests, and nutrition survey. The 1,725 data sets from adult patients in the KNHANES VII-2 who had multiple chronic conditions were used in this study. All of the participants in this study were adult patients aged 19 years and above with two or more chronic diseases who were living in the community.

The KNHANES provides open data to researchers, which may be utilized after registration. The raw data do not include any personal identifiers and thus comply with the Personal Information Protection Act and Statistics Act. This study was exempted from review by the institutional review board of Seoul National University.

**Study Variables**

The variables focused on in this study included living arrangement, sedentary behavior, and health-related quality of life. The covariates addressed included gender, age, employment status, and number of chronic diseases, which have been reported in previous research as factors associated with quality of life in patients with multimorbidities (Brettschneider et al., 2013; Millá-Perseguer et al., 2019; Rothrock et al., 2010; Tyack et al., 2018). These data were obtained from the health survey section of the KNHANES VII-2.

Living arrangement was determined based on the response of survey participants to a question about the number of members in their household. Sedentary behavior was assessed in terms of the average amount of time (in hours and minutes) that survey participants reported spending sitting or lying down each day outside normal sleeping hours. For convenience, the average amount of time spent in sedentary behavior was expressed in hours only in this study.

Health-related quality of life was investigated using the EQ-5D questionnaire, with scores of 1 = no disruption or no problem, 2 = little disruption or some problems, and 3 = cannot or extreme problems used in each of the five dimensions of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The EQ-5D index value used in this study was converted using the South Korean population-based preference weight, which was established by Y. K. Lee et al. (2009), with negative values, 0, and 1 indicating “worse than death,” “death,” and “full health,” respectively, with higher EQ-5D scores indicating better health-related quality of life. The validity and reliability of the Korean version of EQ-5D have been confirmed in previous studies (Kim et al., 2005; S. I. Lee, 2011).

In terms of the covariates, employment status was categorized into “yes” (employed) or “no” (not employed), and the number of chronic diseases was calculated as the sum of the
“currently prevalent” answers to questions about 33 diseases, including circulatory diseases (hypertension, dyslipidemia, stroke, etc.), musculoskeletal diseases (osteoarthritis, osteoporosis, etc.), respiratory diseases (pulmonary tuberculosis, asthma, etc.), endocrine and metabolic diseases (diabetes, thyroid disease), cancer, digestive diseases (hepatitis B, hepatitis C, etc.), “other” diseases (neurologic, sensory, urinary, reproductive, and dermatological), and eye and ear diseases.

**Statistical Analyses**

Two-stage stratified cluster sampling was used in the KNHANES VII-2. Multiple survey and sampling methods were employed to ensure the nationally representative nature of this database. If an analysis does not consider the sampling procedure when selecting subpopulations from this type of data or when deleting missing cases, the results of the analysis may be biased. Therefore, all of the statistical analyses in this study took into account the components of the complex sampling design, including strata, clusters, weights, and adjustment procedures, with missing data treated in a valid manner (Korea Centers for Disease Control and Prevention, 2019). The significance level was set to .05, and all numbers were rounded off.

Living arrangement was classified as either single household (1) or multiperson household (0). The EQ-5D index, which was used in this study to evaluate health-related quality of life and which was originally a continuous variable, was coded as a dichotomous variable based on the average score of 0.905 because of a ceiling effect in the distribution where many respondents answered “full health” (Song et al., 2018). An above-average quality of life score was coded as 1, and an average or less-than-average score was coded as 0 (2018). The mean value for the quality of life of the participants in this study was used as the cutoff point because the EQ-5D index score based on the Korean population preference weight does not provide a specific index value as a cutoff point.

Multiple logistic regression was conducted to identify the effects of living alone and of sedentary behavior on health-related quality of life. In Model 1, gender, age, employment status, and number of chronic diseases were included as independent variables. In Model 2, living arrangement was introduced and adjusted for gender, age, employment status, and number of chronic diseases. Sedentary behavior was introduced in Model 3.

**Results**

The sociodemographic and health-related characteristics of the participants are shown in Table 1. Of the 1,725 individuals with multiple chronic conditions in the 2017 KNHANES, 1,057 (61.3%) were female. The mean age of the sample used in this study was 60.76 years, with the ≥ 65-year-old group accounting for the largest proportion. In terms of employment status, there were slightly more unemployed individuals (54.6%) than employed individuals (44.9%). The average number of chronic diseases was 2.80, with the largest proportion of participants reporting two chronic diseases (860, 49.9%). Multiperson households (79.7%) outnumbered single households (20.3%). The average duration of sedentary behavior was 8.21 hours, and the average health-related quality of life score was 0.90. The prevalence of each chronic disease (i.e., the frequency of the “currently prevalent” answer for each disease) is shown in Table 2. Hypertension (1,058) was the most common chronic disease, followed by dyslipidemia (775), osteoarthritis (561), and diabetes (482).

The unadjusted odds ratio (OR) for higher health-related quality of life for each variable is as follows. The odds of higher health-related quality of life were greater in men than in women (OR = 2.03, 95% confidence interval [CI; 1.61, 2.56]) and greater in employed individuals than in unemployed individuals (OR = 3.50, 95% CI [2.76, 4.46]). In addition, the odds of higher health-related quality of life decreased with age (OR = 0.95, 95% CI [0.93, 0.97]) and were lower for those with more chronic diseases (OR = 0.62, 95% CI [0.55, 0.69]), who lived in single households.
Table 2
Prevalence of Each Chronic Disease (N = 1,725)

| Chronic Disease        | n    | %    |
|------------------------|------|------|
| Hypertension           | 1,058| 61.3 |
| Dyslipidemia           | 775  | 44.9 |
| Osteoarthritis         | 561  | 32.5 |
| Diabetes               | 482  | 27.9 |
| Cataract               | 361  | 20.9 |
| Osteoporosis           | 360  | 20.9 |
| Allergic rhinitis      | 305  | 17.7 |
| Depression             | 118  | 6.8  |
| Sinusitis              | 109  | 6.3  |
| Asthma                 | 95   | 5.5  |
| Stroke                 | 95   | 5.5  |
| Angina pectoris        | 87   | 5.0  |
| Thyroid disease        | 84   | 4.9  |
| Rheumatoid arthritis   | 79   | 4.6  |
| Glaucoma               | 73   | 4.2  |
| Myocardial infarction  | 58   | 3.4  |
| Atopic dermatitis      | 56   | 3.2  |
| Macular degeneration   | 33   | 1.9  |
| Other cancer 1         | 31   | 1.8  |
| Tymanitis              | 30   | 1.7  |
| Thyroid cancer         | 29   | 1.7  |
| Hepatitis B            | 27   | 1.6  |
| Liver cirrhosis        | 17   | 1.0  |
| Renal failure          | 14   | 0.8  |
| Breast cancer          | 11   | 0.6  |
| Colorectal cancer      | 8    | 0.5  |
| Gastric cancer         | 8    | 0.5  |
| Liver cancer           | 6    | 0.3  |
| Lung cancer            | 6    | 0.3  |
| Hepatitis C            | 6    | 0.3  |
| Cervical cancer        | 5    | 0.3  |
| Pulmonary tuberculosis | 2    | 0.1  |
| Other cancer 2         | 1    | 0.1  |

Note. “Other cancer 1” indicates cancers other than thyroid, breast, colorectal, gastric, liver, lung, and cervical cancers. “Other cancer 2” indicates having one more “other” cancer.

Multiple logistic regression was performed to identify the effects of living arrangement and sedentary behavior on quality of life (Table 3). Model 1 is a basic regression model that included gender, age, employment status, and number of chronic diseases ($R^2 = .21, p < .001$). The odds of high health-related quality of life were found to be greater in men than in women ($OR = 1.39, 95\% CI [1.06, 1.82]$) and in employed individuals than in unemployed individuals ($OR = 2.20, 95\% CI [1.59, 3.04]$). Furthermore, the odds of high health-related quality of life decreased with age ($OR = 0.97, 95\% CI [0.95, 0.99]$) and in participants with more chronic diseases ($OR = 0.75, 95\% CI [0.66, 0.84]$). The living arrangement variable was introduced in Model 2 ($R^2 = .21, p < .001$). After adjusting for gender, age, employment status, and number of chronic diseases, the odds of high health-related quality of life were shown to be lower in participants living in single households than in those living in multiperson households ($OR = 0.62, 95\% CI [0.46, 0.84]$). The sedentary behavior variable was introduced in Model 3 ($R^2 = .22, p < .001$). After adjusting for gender, age, employment status, number of chronic diseases, and living arrangement, the odds of high health-related quality of life decreased as sedentary time increased ($OR = 0.93, 95\% CI [0.89, 0.96]$).

Discussion
Multimorbidity has become a global health priority (Navickas et al., 2016) and is a growing issue in nursing. Research into the impact of multimorbidity on patients’ lives may support nurses’ daily practice (O’Connor et al., 2018). Moreover, identifying the social factors that relate to the health of patients with multimorbidities is important for nurses to help them understand the context and barriers that patients experience (Northwood et al., 2018). This study focused on the quality of life of individuals with multimorbidities and explored the related factors.

Number of chronic diseases was found to be associated with their health-related quality of life. This result is consistent with previous research. A recent review also reported that having multiple diseases is closely correlated with quality of life (Makovski et al., 2019). Moreover, in the South Korean population with multimorbidity, it has been shown that an increased number of chronic diseases is a predictor of low health-related quality of life in young adults as well as older adults (Joe et al., 2016). Adding one chronic condition causes more-complicated care issues.

In this study, living arrangement was found to be a significant predictor of health-related quality of life in patients with multiple chronic diseases, even after controlling for age, gender, employment status, and number of diseases. The effect of living alone on persons with multiple chronic diseases has rarely been studied. Nevertheless, some studies have explored the health outcomes of living alone by focusing on a single chronic condition such as cardiovascular disease, diabetes, and cancer. Ma (2018) found that older people with hypertension who live alone exhibit more depressive symptoms. It has also been reported that patients with heart failure who live alone have higher readmission rates than those who live with family members (Lu et al., 2016). Moreover, living alone is associated with lower...
angina-related quality of life and higher mortality after myocardial infarction (Buolol et al., 2011; Schmaltz et al., 2007). Thus, living alone has been reported as a factor associated with negative health outcomes among persons with chronic diseases. The findings of this study support this association in the population with multimorbidity.

A reason for the poorer health-related quality of life experienced by patients who live alone compared with that of those who live with family may be that they find it more difficult to manage their disease. Uchmanowicz et al. (2018) found that older adults with hypertension who live alone have a lower level of treatment adherence. As living alone affects the disease management of patients with a single chronic condition, having multiple chronic conditions may affect this even more. In addition to disease management, activities of daily living may be another issue. There may be more barriers to food preparation, which is essential for a good health condition (Miyawaki et al., 2016). Household chores that help maintain a healthy and clean environment may also be more of a burden for patients who live alone. People with multiple chronic conditions have complex care needs. Thus, the families’ and carers’ contributions are important for helping patients manage their disease and their daily life to maintain health (O’Connor et al., 2018).

Another reason for lower health-related quality of life may be loneliness and social isolation. Living alone has been reported to be associated with loneliness and social isolation in general, which impacts health-related quality of life, particularly in the dimension of mental health (Beutel et al., 2017; Ge et al., 2017). Various nursing interventions have been developed to prevent or reduce loneliness and social isolation, including facilitating interpersonal interactions, conducting psychological therapies with group activities, providing health and social care support, and organizing leisure activities (Gardiner et al., 2018). More research is needed to develop and test the effects of nursing interventions that are tailored to patients with comorbidities who live alone in the community.

In this study, sedentary behavior was found to be a significant predictor of health-related quality of life after controlling for age, gender, employment status, number of diseases, and living arrangement. For patients with chronic diseases, sedentary behavior may be a factor that worsens their health conditions. Sedentary behavior in patients with rheumatoid arthritis, for example, may exacerbate inflammation, resulting in increased pain, fatigue, and depression and decreased quality of life (Fenton et al., 2018). The findings of this study are meaningful as they elucidate the association between sedentary behavior and quality of life in populations with multimorbidities.

Although sedentary behavior is a risk factor affecting quality of life in patients with multimorbidities, the average number of sedentary hours in this study of 8.2 hours per day is more than the average 6.1 hours per day among the adult population in South Korea (Park et al., 2018). More research should be performed on nursing interventions that are designed to reduce sedentary hours and encourage a more active life and are tailored for multiple chronic conditions. Moreover, nurses who work with patients with multimorbidities need to plan strategies to curtail sedentary lifestyle habits. This might help people with multimorbidities to achieve a better quality of life.

This study has several limitations. First, the sum of the “currently prevalent” answers was used as the criterion for multimorbidity instead of examining medical records. Second, the effect of sedentary behavior on health-related quality of life may vary according to the signs/symptoms or severity of disease. This issue could not be addressed in this study because of the characteristics of the data. Third, this study could not consider variables beyond what was

### Table 3

| Variable (Category)                   | Model 1          | Model 2          | Model 3          |
|--------------------------------------|------------------|------------------|------------------|
|                                      | Adjusted OR      | 95% CI           | p                | Adjusted OR      | 95% CI           | p                | Adjusted OR      | 95% CI           | p                |
| Gender                               | Gender           |                  |                  | Gender           |                  |                  | Gender           |                  |                  |
| Male (ref: female)                   | 1.39 [1.06, 1.82] | .016             | .016             | 1.37 [1.05, 1.79] | .023             | .015             |
| Age                                  | 0.97 [0.95, 0.99] | .001             |                  | 0.97 [0.95, 0.99] | .001             |                  | 0.97 [0.95, 0.99] | .001             |
| Employment status                    | Employment status|                  |                  | Employment status|                  |                  | Employment status|                  |                  |
| Yes (ref: no)                        | 2.20 [1.59, 3.04] | < .001           | < .001           | 2.15 [1.57, 2.95] | < .001           | < .001           | 1.99 [1.46, 2.70] | < .001           |
| Number of chronic diseases           | Number of chronic diseases | 0.75 [0.66, 0.84] | < .001 | 0.76 [0.67, 0.85] | < .001 | 0.79 [0.70, 0.89] | < .001 |
| Living arrangement                   | Living arrangement | 0.62 [0.46, 0.84] | < .001 | 0.66 [0.47, 0.91] | < .001 | 0.66 [0.47, 0.91] | < .001 |
| Single household (ref: multiperson household) | 0.93 [0.89, 0.96] | < .001           |                  |                  |                  |                  |
| Sedentary behavior                   |                  |                  |                  |                  |                  |                  |                  |                  |
| Nagelkerke $R^2$                      |                  | .21, $p < .001$  |                  | .21, $p < .001$  |                  | .22, $p < .001$  |                  |

Note. OR = odds ratio; CI = confidence interval; ref = reference.
available in the original data set, and the range of control and the application of data were limited because this was a secondary analysis. Moreover, this study divided subjects into high EQ-5D and low EQ-5D groups using the average score of all participants. Therefore, the results must be interpreted cautiously. Finally, the health-related quality of life was not classified as a dimension in this study. Future study may examine if each dimension of the health-related quality of life is more greatly affected by living arrangement or sedentary behavior.

This study was the first in South Korea to identify the effects of living arrangement and sedentary behavior on health-related quality of life in patients with multiple chronic conditions. In addition, more-generalized results were obtained regarding adults of all ages using representative data from a population-based survey.

Conclusions
Multimorbidity is a global issue. Helping people with multimorbidities experience a better quality of life is an important part of the daily practice of nurses. In addition, living alone may increase the probability of patients with multimorbidities belonging to a comparatively lower-quality-of-life group. Nursing interventions that are tailored to patients who live alone should be helpful in managing the complicated issues that arise from having more than one disease. Moreover, sedentary behavior, which is a global health risk, increases the risk of having a comparatively lower quality of life in patients with multimorbidities. Their quality of life may be improved by making an effort to reduce their sedentary behavior.

Author Contributions
Study conception and design: All authors
Data collection: All authors
Data analysis and interpretation: All authors
Drafting of the article: All authors
Critical revision of the article: All authors

Accepted for publication: September 19, 2020
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The authors declare no conflicts of interest.

Cite this article as:
Ahn, Y. E., & Koh, C. K. (2021). Effects of living alone and sedentary behavior on quality of life in patients with multimorbidities: A secondary analysis of cross-sectional survey data obtained from the national community database. The Journal of Nursing Research, 29(5), Article e173. https://doi.org/10.1093/jnr.000000000000048

References
Beutel, M. E., Klein, E. M., Brähler, E., Reiner, I., Jüngler, C., Michal, M., Wittink, J., Wild, P. S., Münzel, T., Lackner, K. J., & Tibubos, A. N. (2017). Loneliness in the general population: Prevalence, determinants and relations to mental health. BMC Psychiatry, 17(1), Article No. 97. https://doi.org/10.1186/s12888-017-1262-x

Brettsschneider, C., Leicht, H., Blickel, H., Dahlhaus, A., Fuchs, A., Gensichen, J., Maier, W., Riedel-Heller, S., Schafer, I., Schon, G., Weyerer, S., Wiese, B., van den Bussche, H., Scherer, M., Konig, H. H., & MultiCare Study Group. (2013). Relative impact of multimorbidity chronic conditions on health-related quality of life—Results from the multicare cohort study. PLOS ONE, 8(6), Article e66742. https://doi.org/10.1371/journal.pone.0066742

Bucholz, E. M., Rathore, S. S., Gosch, K., Schoenfeld, A., Jones, P. G., Buchanan, D. M., Spertus, J. A., & Krumholz, H. M. (2011). Effect of living alone on patient outcomes after hospitalization for acute myocardial infarction. The American Journal of Cardiology, 108(7), 943–948. https://doi.org/10.1016/j.amjcard.2011.05.023

Fenton, S. A. M., Veldhuijzen van Zanten, J. J. C. S., Duda, J. L., Metsios, G. S., & Kitas, G. D. (2018). Sedentary behaviour in rheumatoid arthritis: Definition, measurement and implications for health. Rheumatology, 57(2), 213–226. https://doi.org/10.1093/rheumatology/kex053

Gardiner, C., Geldenhuys, G., & Gott, M. (2018). Interventions to reduce social isolation and loneliness among older people: An integrative review. Health and Social Care in the Community, 26(2), 147–157. https://doi.org/10.1111/hsc.12367

Ge, L., Yap, C. W., Ong, R., & Heng, B. H. (2017). Social isolation, loneliness and their relationships with depressive symptoms: A population-based study. PLOS ONE, 12(8), Article e0182145. https://doi.org/10.1371/journal.pone.0182145

George, S. M., Alfano, C. M., Groves, J., Karabulut, Z., Haman, K. L., Murphy, B. A., & Matthews, C. E. (2014). Objectively measured sedentary time is related to quality of life among cancer survivors. PLOS ONE, 9(2), Article e87937. https://doi.org/10.1371/journal.pone.0087937

Heyworth, I. T., Hazell, M. L., Linehan, M. F., & Frank, T. L. (2009). How do common chronic conditions affect health-related quality of life? British Journal of General Practice, 59(568), e353–e358. https://doi.org/10.3399/bjgp09X453990

Joe, S., Lee, I., & Park, B. (2016). Factors influencing health-related quality of life of young adults and elderly with multimorbidity: A secondary analysis of the 2013 Korea Health Panel Data. Journal of Korean Academy of Community Health Nursing, 27(4), 358–369. https://doi.org/10.12799/jkahcn.2016.27.4.358

Kim, M.-H., Cho, Y.-S., Uhm, W.-S., Kim, S., & Bae, S.-C. (2005). Cross-cultural adaptation and validation of the Korean version of the EQ-5D in patients with rheumatic diseases. Quality of Life Research, 14(5), 1401–1406. https://doi.org/10.1007/s11136-004-5681-z

King, D. E., Xiang, J., & Pilkerton, C. S. (2018). Multimorbidity trends in United States adults, 1988–2014. The Journal of the American Board of Family Medicine, 31(4), 503–513. https://doi.org/10.3122/jabfm.2018.04.180008

Korea Centers for Disease Control and Prevention. (2019). The 11th National Health and Nutrition Examination Survey and Youth Risk Behavior Web-Based Survey Data Utilization Workshop. Author. https://knhanes.cdc.go.kr/knhanes/sub03/sub03_07_01.do (Original work published in Korean)

Lee, S. I. (2011). Validity and reliability evaluation for EQ-5D in Korea. Korea Centers for Disease Control and Prevention. http://www.ndsl.kr/ndsl/commons/util/ndslOriginalView.do?cn=TRKO201300000474&dbt=TRKO (Original work published in Korean)

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