沖縄県在住祖母の育児支援，身体活動およびHRQOLとの関連

学位論文

Relationship between child-rearing assistance, physical activity, and health-related quality of life among Okinawan grandmothers

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Relationship between child-rearing assistance, physical activity, and health-related quality of life among Okinawan grandmothers

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Abstract

Appropriate physical activity (PA) enhances health-related quality of life (HRQOL) in the elderly. However, few studies have focused on the physical activity required during grandparenting activities. We investigated the levels of PA and HRQOL in 48 Japanese grandmothers and determined the association between child-rearing assistance and PA and between PA and HRQOL. The study revealed that the grandmothers mainly provided non-daily care, and they showed an appropriate level of PA and good physical and mental HRQOL. These findings suggest that involvement in non-routine care has benefits for grandparents' health.

Keywords: grandmother, grandparenting, physical activity, health-related quality of life

Introduction

Increasingly, grandparents are engaged in providing child-rearing assistance for their grandchildren and are playing an important supportive role in sustaining the work-life balance of the younger generation (Geurts et al., 2014; the Cabinet Office of Japan, 2012). According to a survey conducted in the United States and 23 European countries, the generational transition from parents to grandparents typically starts in the fifth decade of life, and by the age of 70 more than 80% become grandparents (Leopold & Skopek, 2015). A survey of Asian Americans revealed that most grandparents responsible for raising grandchildren were in their 60s (Phua & Kaufman, 2008). However, major transformations in mental and physical health start to occur in the fifties. It has been suggested that aging, changes in social roles, and added responsibilities of providing childcare assistance for grandchildren (grandparenting) may lead to enhanced physical and mental burdens in this population group.

Numerous studies of grandparenting participation have examined the impact of grandchildren's socio-demographic status as well as the degree of involvement in grandparenting on the physical and mental health of grandparents (Craig & Jenkins, 2016b; Di Gessa et al., 2016; Doley et al., 2015; Lo & Liu, 2009; Nakano et al., 2016; Tang et al., 2016; Triadó et al., 2014; Xu, 2019). In contrast, no studies have considered the child-rearing assistance provided by grandparents as a physical activity (PA) or elucidated the actual levels of PA of grandparents and its relationship with their health-related quality of life (HRQOL). Therefore, the present study was designed to address this question.

Literature Review

Grandparenting Care

Craig and Jenkins (2016) defined grandparenting as encompassing either routine childcare (physical activities such as feeding, bathing as well as accompanying and transporting children) or non-routine care (talk-based care including reading, teaching, talking and minding such as caring for children without active involvement, and monitoring children). They reported that grandmothers were more involved in providing childcare assistance than grandfathers, and non-routine care accounted for 60% of grandparenting care (Craig & Jenkins, 2016a). A survey of Taiwanese and Japanese grandparents found that grandparenting tasks were more common among women than men (Kitamura, 2015; Park, 2018; Yaegashi et al., 2013).

Miyanaka (2001) classified the child-rearing assistance provided by Japanese grandmothers into the following three categories (1) direct assistance which directly supports the grandchild, (2) indirect assistance which involves providing support to the grandchild through the grandchildren's mother, (3) socio-cultural assistance constitutes the socialization of grandchildren and playing with grandchildren including activities such as reading books and transmission of Japanese culture through traditional form of play such as Origami, a paper folding craft.

Surveys of Japanese grandparents with preschool-aged grandchildren asked respondents to rank-order the frequency of child-rearing help they provided. The reported order of frequency in their involvement was as follows: socio-cultural and financial assistance

such as playing, buying gifts, and teaching manners; direct assistance involving physical activity (PA) such as preparing and serving a grandchild's meals; and indirect assistance involving less PA such as advising and consulting with parents (Kitamura, 2008; Miyanaka, 2001; Yaegashi et al., 2013). Similarly, according to a survey by the Cabinet Office, the highest-ranked areas of support for Japanese grandchildren under the age of 18 years were material or financial support and assistance concerning taking care of or looking after a grandchild (The Cabinet Office of Japan, 2012). Based on these reported findings, we concluded that childcare assistance provided by grandparents primarily focuses on non-routine or socio-cultural assistance. Furthermore, it was the grandmothers who served the major grandparenting role.

However, these reports failed to clarify the implementation logistics of each childcare activity and the status of childcare that is conducted in parallel with other activities such as work and volunteer activities. Furthermore, when multiple children are being raised, various childcare activities are being performed in parallel; therefore, it is unclear which type of childcare assistance is the most common.

Impact of PA on the Health of Older Adults, Actual Conditions of PA in Older Adults

It is worthwhile considering what kinds of grandchild-care assistance become a burden to middle aged to older adults; examining the issue from the aspect of PA, is particularly relevant given the fact that these older adults are aware of their mental and physical decline due to aging.

To promote and maintain a healthy status for adults between 18 and 65 years of age, the American College of Sports Medicine (ACSM) recommends moderate-to-vigorous PA of at least three metabolic equivalents (METs) for a minimum of 30 minutes per day on 5 days per week (150 minutes per week) (Haskell et al., 2007). In Japan, the Ministry of Health, Labour and Welfare (MHLW) established the PA guidelines for health promotion for Japanese citizens aged 18 years and older. It is recommended that adults aged 18‐64 years must engage in at least 3 METs of PA (moderate-to-vigorous PA) for at least 60 minutes a day; meanwhile the elderly, aged 65 and older, who have a sufficient level of physical fitness, should conduct PA for at least 40 minutes per day, regardless of intensity (Japan Ministry of Health, Labour and Welfare, 2021b). In fact, low levels of moderate-to-vigorous PA in older adults are related to the incidence of various diseases, such as coronary heart disease (Batty, 2002), cognitive dysfunction (Larson et al., 2006), and a low level of health-related quality of life (HRQOL) (Aoyagi et al., 2010; Xu et al., 2018). Recently, the adverse effects of sitting long hours, as well as the state of inactivity on health, have caught an equally large share of attention as the insufficiency of moderate-to-vigorous PA (Owen et al., 2010). In systematic reviews of sedentary behavior among people who are 60 years and older, sedentary behaviors were associated with an increased risk of metabolic syndrome, obesity, and mortality from various disorders (de Rezende et al., 2014). Warburton and Bredin (2017) show that replacing sedentary behavior with a light intensity of physical activity, even to a low level, brings a clear benefit to health.

What is the actual level of PA or sedentary state in the grandparent generation?

Measurements of moderate-to-vigorous PA using accelerator in elderly Japanese aged 65 years and older has been reported at 46.5 minutes/day (Honda et al., 2014) or 52.3 minutes/day (Chen et al., 2020). A report similar to the above-mentioned Japanese one, this time based in UK, surveyed 118 elderly men, and the mean moderate-to-vigorous PA was 42 minutes/day (Jefferis et al., 2016). A large-scale survey of adults aged 60 years and older in the United States, and Germany (n = 475 to 1,260) showed lower levels of moderate to vigorous PA than their Japanese counterparts: the mean was 6.5 min/day (Troiano et al., 2007) and 35 min/day (Luzak et al., 2017) in males, and from 5.8 (Troiano et al., 2007) and 28 min/day (Luzak et al., 2017) in females. There are few reports that measure PA that is lighter than moderate to vigorous PA (MVPA) using an accelerometer in the elderly population. In limited reports where light physical activity (LPA) was measured, it took place for longer (male 208 min/day and female 205 min/day in Canadian research; 341 min/day in Japanese research) than MVPA (male 17 min/day and female 12 min/day in Canadian; 52.3 min/day in Japanese) (Chen et al., 2020; Colley et al., 2011).

Regarding the sedentary time, a systematic review of quantitative studies conducted in seven countries, including the United States, Europe, and Japan, reported that 67% of the aging population was routinely sedentary for 8.5 hours or more per day (Harvey et al., 2013). In the Health Measures Survey in Canada, males aged 60–79 years spend an average of 9.9 hours per day in a sedentary state while females spend 10.3 hours (Colley & Janssen, 2011). In addition, males and females aged 60 years and over living in central China showed results (male 9.8 hours and female 9.9 hours) similar to those of the Canadian survey (Wu et

al., 2020). On the other hand, a recent report of the sedentary time in a Japanese aging population of 65 years and over found 7.6 (Chen et al., 2020) and 8.1 hours per day (Honda et al., 2014), which was shorter than the findings of Colley and Janssen (2011), Harvey et al. (2013), and Wu et al. (2020). Taken together, the review of literature on PA suggests that moderate-to-vigorous PA data in Japanese older adults meets the MHW criteria and the ACSM recommendations for those aged 65 years and older. Older adults spent more time of LPA than moderate-to-vigorous PA, and the sedentary time of the Japanese elderly might be shorter than for the elderly in other countries.

Reports of PA, including sedentary behavior in older adults has mainly been studied as a function of age (Colley et al., 2011; Jefferis et al., 2016; Troiano et al., 2007), gender (Colley et al., 2011; Honda et al., 2014; Luzak et al., 2017; Troiano et al., 2007; Wu et al., 2020), in relation to health conditions such as metabolic syndrome (Honda et al., 2014; Jefferis et al., 2016; Luzak et al., 2017) or frailty (Chen et al., 2020). Vermote et al. (2021) noted that the role of PA in providing care for grandchildren and in the sedentary behavior of grandparents and HRQOL is yet to be investigated. Thus, they announced a prospective cohort study protocol (study protocol of the Healthy Grandparenting Project) on PA and HRQOL for grandparents who are involved in child-rearing in Belgium. To the best of our knowledge, few studies have focused on PA from the perspective of grandparenting or child-rearing assistance provided by grandparents.

Therefore, in the present study, we assessed PA using an accelerometer in grandmothers who bore the principal responsibility of providing child-rearing assistance to

the younger generation.

Grandparenting and HRQOL

Both positive and negative outcomes have been reported for the relationship between grandparenting and grandparents' health. Grandparents involved in child-rearing assistance were noted to be healthier in several studies (Di Gessa et al., 2016; Xu, 2019), with additional benefits of psychological well-being (Tang et al., 2016). In contrast, grandmothers who regularly provided child-rearing assistance or those juggling child-rearing assistance with employment reported feeling constrained for time (Craig & Jenkins, 2016b). Furthermore, custodial grandparents reported a high score of anxiety, stress, depression, and a low life satisfaction score (Doley et al., 2015). In another study, no significant differences were reported in accumulated fatigue between grandmothers who did or did not engage in grandparenting (Nakano et al., 2016). Additionally, grandparenting and the frequency or type of childcare did not affect depression or quality of life (Lo & Liu, 2009), and their health and well-being (Triadó et al., 2014).

In summary, studies evaluating the effect that grandparenting has on grandparents' health and well-being have yielded inconsistent results. Furthermore, these studies mainly focus on health or well-being using a psychological scale and the presence or absence of illness. None of the studies have considered grandparenting as a surrogate for PA. The relationship between PA levels and child-rearing assistance has remained unexplored. Moreover, the effects of these variables in the context of grandparenting for multiple

grandchildren are as yet undetermined.

Objectives and Hypotheses

The aims of this study were: (a) to describe the scope of child-rearing assistance provided by grandmothers, the levels of their PA, and their HRQOL; (b) to identify the association between child-rearing assistance provided by grandmothers and PA; (c) to clarify the association between PA and HRQOL. Based on the literature review, we hypothesized that childcare assistance involves non-routine or socio-cultural assistance, and that it was grandmothers who served the major role in grandparenting. PA of grandparents is of light intensity rather than moderate to vigorous PA, and the moderate to vigorous PA of grandparents meets international criteria. We speculated that if grandparents have a high level of responsibility for grandchild-care, their HRQOL level may drop. They might show a good HRQOL level when their PA meets PA criteria.

Methods

Study Design

This study employed a cross-sectional descriptive correlational design. The study was approved by the Ethical Committee on Epidemiological Research at the University of the Ryukyus.

Participants and Procedures

In previous studies, grandmothers were found to be more involved in childcare assistance than grandfathers (Craig & Jenkins 2016a; Kitamura 2015; Park 2018; Yaegashi et al., 2013); therefore, we focused on grandmothers in this study. We targeted the Women's Society as an organization from which to recruit study participants. The Women's Society is an organization engaged in activities related to gender equality and development of the youth in Japan, which mainly involves married women. In the Okinawa Prefecture, branches in 26 cities, towns, and villages are affiliated with this society. The selection of the target branches was carried out by the following procedure. First, to ease the process of random selection, we assigned a number to 15 branches on the main island of Okinawa, excluding 11 branches on remote islands. Next, in order to eliminate bias on target branch due to the confounding effect of district, the Okinawa main island was divided into three (A, B, C) batches based on the number of district divisions. From each district, two or three branches were randomly selected, according to the ratio (A 27%, B 33%, and C40%, respectively) of the number of branches in a district to the total number of the Women's Society branches on Okinawa main island. We invited seven branches of the Women's Society to participate in our study; out of these, two branches agreed to participate. The objectives and ethical considerations of this study were discussed with the president of each women's society in each participating target area.

Sixty-nine Japanese grandmothers, introduced by the society president, participated in this study. All participating grandmothers had grandchildren under 18 years of age. The study participants were surveyed between May and August 2013. After receiving consent

from the participants, a triaxial accelerometer and the HRQOL questionnaire were distributed, and the participants were asked to complete the questionnaire on the last day of the PA measurement. After completion, the questionnaire was sealed in an envelope and was collected directly by the researchers seven to ten days after distribution. Seven participants with less than four days of PA measurements and 14 who failed to answer questionnaire items were excluded. The remaining 48 responses were used for analyses.

Measurements

Physical Activity (PA)

Participants wore a triaxial accelerometer (Active Style Pro HJA-350IT, Omron Healthcare Co. Ltd., Kyoto, Japan) on the waist for five weekdays except while bathing or sleeping. Physical activity data were recorded during one-minute intervals using a triaxial accelerometer. These instruments can be used to evaluate the timing of locomotive activities (walking or running) and non-locomotive activities (such as activities performed in a sitting or standing position) using METs per unit time. Furthermore, the intensity of non-locomotive activities can be estimated more accurately than by conventional methods (Ohkawara et al., 2011). Only participants with a wearing time of longer than 10 hours and a measurement period of at least four days were included in the analysis as previously reported (Honda et al., 2014).

METs are units used to indicate the intensity of PA, with one MET being equivalent to the volume of oxygen consumption while sitting at rest. The range for METs varies from 0.9

(sleeping) to 23 (running at 14 mph) (Ainsworth et al., 2011; Ainsworth et al., 2021). The measured data were classified into three groups of PA (Harvey et al., 2013; Honda et al., 2014; Shibata et al., 2018): 1–1.5 METs as sedentary state, 1.6–2.9 METs as LPA, and 3 METs or over as MVPA.

Questionnaire

Demographic Data

Information about participants' age, other persons living in their households, and employment status was collected.

Characteristics of Child-rearing Assistance

The questionnaire gathered information about the age of grandchildren, whether the grandchildren attended preschool or school, the employment status of the grandchildren's mother, and the grandparents' frequency of contact with their grandchildren. Data analysis was limited to those with up to four grandchildren, as grandmothers with five or more grandchildren tended to have a large volume of missing data. When participants were taking care of multiple grandchildren, they were classified in the group to which most of their grandchildren belonged to. For example, a grandmother with 3 grandchildren aged 1, 3, and 7 was classified in the group "under 3-year-old." In addition, we included 17 survey items concerning the four types of child-rearing assistance or grandparenting that had been identified in previous studies of Japanese grandparents (Kubo et al., 2011; Miyanaka, 2001;

Yaegashi et al., 2003). Child-rearing assistance was categorized into: a) physical assistance which is directly provided (instrumental support): including changing clothes, helping with meals, changing diapers, potty training, bathing, and napping; b) accompanying assistance which is indirectly provided: transportation to school, lessons or clubs, hospital visits c) sociocultural/financial assistance which is socialization or cultural training of grandchildren, playing, reading books, disciplining and monetary support buying gifts; and d) housework assistance such as shopping, cleaning up after a meal, cooking, laundry, house cleaning, etc. Although previous studies (Miyanaka, 2001; Yaegashi et al., 2003) have included the emotional or informational assistance category, the present study excluded this category as it is unrelated to PA. On the last day of PA measurement, we asked the participants to answer whether or not they had undertaken 17 items of child-rearing assistance during the PA measurement period; the number events was analyzed.

HRQOL

We assessed HRQOL using a Japanese version of the Medical Outcomes Study Short Form-8 survey (SF-8). The Japanese translation and the reliability and validity of this scale for the Japanese population have been verified in a previous study (Fukuhara & Suzukamo, 2005). The eight items were assessed on a 5- or 6-point Likert scale and included eight subscales: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), emotional roles (RE), and mental health (MH).

In the current study, we adopted norm-based scoring (NBS) based on national

standards in Japan, and each subscale ranging from 0–100 (mean: 50; standard deviation: 10) was determined (Fukuhara & Suzukamo, 2005). Final scoring from the raw scores of the participants in this study was performed using a dedicated software provided by the Institute for Health Outcomes and Process Evaluation Research. Higher scores indicated better QOL. SF-8 can also assess the physical component summary (PCS) and the mental component summary (MCS). The PCS contains four domains (PF, RE, BP, and GH), and MCS contains four (VT, SF, RE, and MH). In the present study, we only analyzed the NBS of each item. The Cronbach's alpha coefficient was 0.79 for the eight items in this study.

Ethical Considerations

Participants completed the survey and measurements after they had read a written statement about the study purpose, the voluntary nature of participation, and their guaranteed right to refuse to answer questions. All participants signed a consent form and received a signed copy of the form.

Data Analysis

Descriptive statistics were determined for participants' demographic information, child-rearing assistance characteristics, PA, and HRQOL. Median and first quartile–third quartile range (Q1–Q3) from the sample were used for statistical analyses as the data were not normally distributed. We utilized hierarchical cluster analysis (Ward's method) to identify the characteristics of assistance patterns. Mann-Whitney U test or Kruskal-Wallis test with post-

hoc Dunn-Bonferroni analysis was performed to identify the association between assistance characteristics and PA. Spearman's correlation analysis was performed to examine the bivariate relationship between child-rearing assistance and PA, and PA and HRQOL. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 22.0 J (IBM Corp., Armonk, New York, USA). A p-value < 0.05 was considered statistically significant.

Results

Data Regarding Child-rearing Assistance Provided by Grandmothers and the Levels of PA and HRQOL for Grandmothers

The median age of all the participants was 62 years (Q1–Q3: 57.3－65) and 19 participants (39.6%) were employed. Forty-three (89.5%) participants were living with a spouse/partner and nine (19.6%) were living with a grandchild. The median number of grandchildren was three (2–5.3). Eleven (22.9%) were caring for one grandchild, 25 (52.1%) for two or three, twelve (25%) for four or over. Under 3-year-old was the largest (43.8%) age group of grandchildren receiving care in this study (Table 1). In addition, 60.4% of the grandchildren attended preschool or school, 63.8% of the grandchildren's mothers were employed, and 43.8% of the participants provided child-rearing assistance every day.

Hierarchical clustering was performed on assistance patterns, and three assistance pattern clusters were classified based on the distance of the obtained dendrogram with a coefficient of 15. Cluster 1, which included 22 grandmothers, was characterized by greater

sociocultural/economic support (mainly sociocultural/economic) assistance than other forms; Cluster 2 (16 grandmothers) involved physical care assistance (mainly physical); Cluster 3 (10 grandmothers) included all types of childcare assistance (comprehensive child-rearing assistance) (Table 2). The assistance patterns varied with grandchildren's age; the under 3-year-old group received mainly physical care (52.4%), while the 4–6-year-old group (53.8%) and over 7-year-old group (50%) were given mainly sociocultural/economic assistance.

Most of the time spent wearing the triaxial accelerometer (median: 441.1 minutes/day) and percentage of wearing time (51.4%) was spent in LPA. Sedentary state accounted for 357.1 minutes/day or 43.0%, and MVPA for 46.0 minutes/day or 5.7%. At all activity intensity levels, the time and percentage of non-locomotive activity were the highest (LPA for 367.3 minutes/day or 86.5%, and MVPA for 26.4 minutes/day or 67.4%) (Table 3).

The scores of SF-8 were as follows: PF 53.5 (47.8－53.5), RP 54.1 (47.4－54.1), BP 52.5 (46.1－60.4), GH 50.3 (50.3－58.5), VT 53.7 (46.8－53.7), SF 55.1 (37.7－55.1), RE 54.2 (48.0－54.2), and MH 56.9 (44.9－56.9).

Association between Child-rearing Assistance and PA

Significant associations were observed between child-rearing assistance characteristics and PA (Table 4-1 and Table 4-2). Grandmothers caring for mainly 4–6-year-olds spent less sedentary time (H [2] = 6.78, p = 0.034; Dunn-Bonferroni, p = 0.040). Furthermore, those caring for under 3-year-olds (H [2] = 8.60, p = 0.014; Dunn-Bonferroni,

vs. the over 7-year-old group, p = 0.032) and 4–6-year-olds (Dunn-Bonferroni, vs. over 7-year-old group, p = 0.029) spent more time engaged in MVPA. Grandmothers transporting grandchildren to and from preschool or school, spent more time (U = 180.5, p = 0.045) and a greater proportion of the day (U = 178.0, p = 0.040) engaged in MVPA. By contrast, there were no significant associations between child-rearing assistance characteristics and LPA. Besides, no significant association was detected between PA and number of grandchildren, employment status of grandchildren's mother, frequency of contact with grandchildren, and assistance patterns.

Table 5 shows the correlation between the number of types of assistance patterns and PA in child-rearing assistance characteristics (age group of the grandchild who received child-rearing assistance) that were significantly associated with PA. In grandchildren under 3-year-olds, there was a negative correlation between physical and total MVPA (r = -0.47, p = 0.032), and physical and locomotive MVPA (r = -0.50, p = 0.020). At 4–6-year-olds, there was a negative correlation between accompanying and total LPA (r = -0.60, p = 0.031), and accompanying and non-locomotive LPA (r = -0.62, p = 0.025). Meanwhile, a positive correlation was observed between physical and total LPA (r = 0.54, p = 0.045) in the over 7-year-old group.

Association between PA and HRQOL

Correlation analysis between PA and HRQOL identified significant positive correlations between locomotive LPA time and PF (r = 0.31, p = 0.042), MVPA time and RP (r = 0.32, p =

0.034), and locomotive MVPA time and RP (r = 0.36, p = 0.017) and VT (r = 0.29, p = 0.047) in all participants (Table 6-1). Furthermore, the results showed positive correlations between total LPA time and BP (r = 0.46, p = 0.037), non-locomotive LPA time and BP (r = 0.44, p = 0.044), total MVPA time and BP (r = 0.44, p = 0.044), and locomotive MVPA time and RP (r = 0.55, p = 0.012), and VT (r = 0.58, p = 0.006) in grandmothers caring for under 3-year-olds. Moreover, there were positive correlations between total LPA time and PF (r = 0.61, p = 0.047) and VT (r = 0.62, p = 0.024); and non-locomotive LPA time and PF (r = 0.61, p = 0.047) and VT (r = 0.59, p = 0.035) in those taking care of 4–6-year-olds. Only locomotive LPA and PF (r = 0.57, p = 0.043) were correlated in those caring for over 7-year-olds (Table 6-2).

Discussion

We demonstrated that child-rearing assistance afforded by grandmothers constitutes PA leading to a satisfactory HRQOL. The factors affecting PA were grandchildren's age and having preschool or school attending grandchildren. Additionally, a positive association was observed between locomotive activity and intensity of PA and the physical domain of HRQOL.

Child-rearing Assistance, PA, and HRQOL Status in Grandmothers

According to the Japanese national census, the percentage of grandparents living with their grandchildren under 18 years of age was 4.8%. This percentage was 4.5% in urban areas and 9.2% in rural areas, a difference of about two-fold (The Statistics Bureau of Japan, 2015). In the Okinawa Prefecture, which is the survey area for the present study, 3.2% of grandparents lived with their grandchildren (The Statistics Bureau of Japan, 2015). A significant proportion

(19.6%) of our study participants lived with their grandchildren, similar to the levels reported in Yamagata Prefecture (18%) which has the highest percentage of three-generation households in Japan. Therefore, our results examining the childcare assistance provided by grandmothers should be interpreted in the context of this high rate of three-generation cohabitation among the study participants.

Nearly half of all the grandmothers enrolled in the study offered sociocultural/financial assistance for their grandchildren, a key component of the non-routine care as defined by Craig and Jenkins (2016). Comparable results have been obtained in other surveys of Japanese grandparents (Kitamura, 2008; Miyanaka, 2001; the Cabinet Office of Japan, 2012; Yaegashi et al., 2013) and also in other countries (Craig & Jenkins, 2016a). Therefore, our results suggest that child-rearing assistance provided by grandparents primarily entails sociocultural/financial assistance across different cultures.

Previous studies report that older adults engage in longer periods of light PA than in moderate to vigorous PA (Chen et al., 2020; Colley et al., 2011). In the present study, we clarified the actual levels of the light-intensity activities for grandmothers involved in childcare. Light-intensity activities accounted for half of their measured movement, with non-locomotive activities being the primary types in both light PA and moderate-to-vigorous PA. Previous studies have shown that American parents (mostly Hispanics) of 2- to 3-year-old children spend 40% of their day engaged in light PA and 2.3% in moderate-to-vigorous PA (Barkin et al., 2017). Furthermore, Japanese fathers' childcare-related PA was mainly light PA with minimal moderate-to-vigorous PA (Yamada et al., 2015). Meanwhile, non-walking

activities have been shown to account for 74% (Yamada et al., 2015) of PA in a day. The total LPA time (mean 304.8 min/day) in kindergarten or nursery teachers was observed to be longer than total moderate-to-vigorous PA time (113.1 min/day) (Tanaka & Tanaka, 2012). Moreover, non-locomotive LPA time (229.2 min/day) in their total LPA time was longer than locomotive LPA time (75.7 min/day). It has been proposed that individuals involved in child-rearing are mainly engaged in non-walking PA. Our results are consistent with these previous reports.

We speculated that moderate-to-vigorous PA in grandmothers would not meet the recommended guidelines for ages 18–64 years. However, our findings of 46 minutes/day met the recommended guidelines for ages 65 years and older in Japan and ACSM. These results were similar to those reported for the Japanese elderly (Honda et al.,2014) and British elderly men with a mean moderate-to-vigorous PA time of 42 minutes/day (Jefferis et al., 2016). Moreover, compared to a previous report (Chen et al., 2020), the time of sedentary state in our study was shorter (456.9 minutes/day vs. 357.1 minutes/day). Clearly, grandmothers involved in child-rearing assistance in the current study were engaged in appropriate PA. The HRQOL scores were higher than in previous reports of adult Japanese women (47.1–50.4) engaged in the recommended amount of PA (Shibata et al., 2007).

Association between Child-rearing Assistance Provided by Grandparents and PA

The moderate-to-vigorous PA of grandmothers with grandchildren under 3 years of age, 4–6 years of age, and preschoolers were consistent with the 2013 MHLW guidelines. Additionally, the sedentary time of 5.7 hours for the 4–6-year-old group was significantly

shorter than that of the over 7-year-old group and was shorter than that reported in elderly Japanese individuals (Chen et al., 2020; Honda et al., 2014). Overall, the data suggested that child-rearing assistance involving preschool- or school-attending children was associated with appropriate levels of PA in grandmothers.

We expected grandmothers caring for preschoolers to exhibit higher levels of intense PA. However, no significant association was identified childcare assistance patterns and PA. Unexpectedly, the physical or all-around assistance patterns did not significantly increase PA. As physical function and health tend to decline with age, participants could have adjusted their PA to a reasonable range according to their overall fitness. In a previous report comparing mother's PA based on the number of children, primiparas were more likely to engage in sedentary activities, whereas multiparas were more likely to engage in slow walking activities (Kokubu, 2004). Moreover, in a previous study that examined PA in three cohorts (parents with no children, first child, or second child), parents with a second child had more LPA than those with no children or first child (Rhodes et al., 2013). These results suggest that caregivers with full responsibility for child-rearing (most Japanese women play this role) have higher PA intensity with an increase in the number of infants. The custodial grandparents fully support their grandchild(ren), and therefore, higher PA is expected in this cohort. Although the present study did not confirm the presence or absence of custodial responsibilities among grandmothers, the percentage of custodial grandparents is reported to be quite low at 0.08% in the survey area (The Okinawa Department of Child Care and Social Welfare, 2021). Therefore, the possibility of custodial grandparents being included in the present study was

low, and it seems to be one of the reasons why there was no association of PA with the number of children. Additionally, almost half of them provided non-routine care (sociocultural/financial assistance) with a low intensity of PA. Kitamura (2008) reported similar levels of childcare assistance by grandmothers regardless of the mothers' occupation. This previously reported finding supports the observed lack of effect of mother's occupation status on grandmothers' PA in the present study.

Regarding child-rearing assistance characteristics (age group of a grandchild receiving child-care from a grandmother) which recognized the significant association with PA, the relationship between child-rearing assistance content and PA was examined for each age group of the grandchild. We expected that the number of physical events and housework involving PA in the types of assistance patterns would be associated with times of light PA and moderate-to-vigorous PA. The physical and light PA duration showed a positive correlation in the age group of 7 years or older, which was consistent with our prediction. However, there were negative correlations with the inverse prediction of physical and moderate-to-vigorous PA times in the 3-year-old group and the accompanying and light PA times in the 4-6 year-old group. Because of the conflicting results among age groups, an association between grandmothers' child-rearing assistance and PA was not identified in this study. During PA measurement, we did not take a lifelog of the types of child-rearing assistance or daily activity, only that childcare was carried out every day, because we considered this a burden for the participants. A case study that measured the amount of PA and lifelogs in first-time mothers with infants found that milk feeding, and cuddling were high intensity child-care activities

(Taki et al., 2017). In the future, it is necessary to implement a method that concretely describes PA content, and to clarify the actual type of PA performed by the grandmothers during childcare, after the types of the child-rearing assistance have been accurately described.

Association between PA and HRQOL in Grandmothers

Recommended amounts of moderate-to-vigorous PA have been shown to positively affect RP (Balboa-Castillo et al., 2011) and VT (Aoyagi et al., 2010; Balboa-Castillo et al., 2011; Takayanagi et al., 2018) in HRQOL. Our study also showed a positive correlation between moderate-to-vigorous PA and the physical and mental domain of HRQOL in all participants. Additionally, in grandmothers caring for under 3-year-olds and 4-6-year-olds who had significantly longer moderate-to-vigorous PA time, based on their child-rearing assistance characteristics, there was a positive correlation between light PA or moderate-to-vigorous PA and the physical and mental domain of HRQOL.

The MHLW recommends exercises aimed at maintaining and improving lower limb muscle functions in order to minimize aging-related restrictions in physical mobility (Japan Ministry of Health, Labour and Welfare, 2021a). Even mild strength training and balance exercises improve lower limb muscle strength in frail elderly people (Okada et al., 2014). Not only moderate-to-vigorous PA but also light PA has been shown to enhance HRQOL (Van et al., 2015) in cancer survivors. Therefore, locomotive light PA may be a means of improving physical HRQOL in those with low PA. Furthermore, in a 2-year prospective cohort study examining the relationship between the type and intensity of PA in female elderly people and

emergence of depressive symptoms up to 2 years later, non-locomotive light PA demonstrated the possibility of reducing future depressive symptoms (Imai et al., 2020; Ku et al., 2018). Although only the 4-6 years-old group showed an association between non-locomotive light PA and mental domain (vitality) in our study, it suggests that involvement in raising grandchildren may be beneficial for grandmothers' mental health.

Although we could not distinguish child-rearing assistance from other daily activities, our results showed that daily light PA or moderate-to-vigorous PA including child-rearing assistance for grandchildren was related to higher physical and mental HRQOL in grandmothers.

Limitations and Future Research

The present study established the potential of child-rearing assistance provided by grandparents in not only maintaining the work-life balance of the younger generation but also in increasing the physical and mental health of the older generation.

Nevertheless, there are important limitations to this study. First, the small sample size and specific study participant characteristics preclude the generalization of these results. The study was conducted on a convenient sample of volunteers. Their active involvement in the community suggests that they were more likely to be physically and mentally active than the general older population. Therefore, enrolling participants who are not involved in a specific society or club may be warranted in future studies. A previous study has reported differences in PA levels between the Japanese and non-Japanese elderly (Colley et al.,2011; Luzak et al.,

2017; Troiano et al., 2007). Thus, these results are likely to be reproducible only in the older Japanese population with similar childcare environments and cultures. Expanding the study's geographical limits and sample size and making a comparison with the PA of older adults of the same age group who do not perform such child-rearing assistance as a control, will enable a thorough understanding of PA levels in grandparents.

Second, while a triaxial accelerometer can be easily worn and provides a reliable estimation of PA intensity (Ohkawara et al., 2011), continuous monitoring while wearing the device may impose considerable stress on the participants. In fact, 10% of the participants were excluded from the analysis due to insufficient measurement data. To increase sample size, future studies may need to employ validated survey tools (e.g., Physical Activity Scale for the Elderly or PASE).

Third, we focused our analysis on the number of child-rearing assistance or grandparenting tasks and activities implemented during the survey period and excluded the frequency of engagement in those activities. Consequently, the association between the frequency of each child-rearing assistance activity and PA was not identified. Additional studies are needed to elucidate this relationship. For example, it is necessary to explore various methods of recording PA that are most conducive to the type of child-rearing assistance taking place at that time, by taking notes of records collected during the PA measurement. In addition, we excluded the emotional or informational assistance category that was classified as quiet/light inactivity (1.3 METs) (Ainsworth., et al., 2021) and included activities as childcare consultation or advice provided by Japanese grandparents (Miyanaka, 2001; Yaegashi et al.,

2003). This was because we assumed that this category was not reflective of the amount of PA. However, in the present study, grandmothers' PA included mainly non-walking activities with LPA.

Both positive and negative outcomes have been reported for the relationship between grandparenting and grandparents' health. Therefore, future studies may need to clarify the relationship between PA and HRQOL, including the contribution of low-intensity childcare assistance (e.g. childcare consultation service and advice) that is often performed at resting states.

Conclusion

Child-rearing assistance is associated with an increase in physical or mental burden for grandparents, especially those involved in custodial responsibilities. However, in this study, grandmothers who mainly provided non-daily care showed an appropriate level of PA and good physical and mental HRQOL. These findings suggest that involvement in non-routine care has benefits for grandparents' health.

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Disclosure statement

The authors report no conflict of interest.

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Table 1. Child-rearing assistance characteristics.

Variables	N	%
Age of main grandchildren receiving care		
Under 3-year-old (range 0–11 years)	21	43.8
4–6-year-old (range 0–12 years)	13	27.0
7-year-old and older (range 1–17 years)	14	29.2
Grandchildren attending daycare, preschool, or school	29	60.4
Employed mother	30	63.8
Frequency of contact with grandchildren		
Up to one time/week	15	31.3
2–3 times/week	12	25.0
Everyday	21	43.8

They were classified into the most frequent group among the grandchildren who provided childcare.

Table 2. Characteristics of assistance patterns.

Types of assistance patterns	Cluster 1 Mainly sociocultural/ economic n = 22	Cluster 2 Mainly physical n = 16	Cluster 3 Comprehensive child-rearing assistance n = 10	Kruskal-Wallis test (H)	Dunn-Bonferroni test
	Median (Q1-Q3)	Median (Q1-Q3)	Median (Q1-Q3)		
Sociocultural/ economic	1.5 (0–3)	2.0 (1–2)	2.0 (1.0–3.3)	0.83	
Housework	1.0 (0–2)	1.0 (0–2)	4.5 (3.0–5.0)	20.39***	Cluster 1, 2 < 3
Physical	0.0 (0–1)	4.0 (3–4)	4.0 (1.5–4.0)	29.98***	Cluster 1 < 2, 3
Accompanying	0.0 (0–1)	1.0 (0–1)	1.5 (0.0–2.3)	7.27*	Cluster 1 < 3

Q1: first quartile; Q3: third quartile.
*** $p < .001$, * $p < .05$.

Table 3. Physical activity in all participants.

	Median (minutes/day)	Q1	Q3	Median (%)	Q1	Q3
Accelerometer wear time	861.6	768.6	908.9			
Total sedentary time	357.1	280.2	412.4	43.0[a]	34.4	49.7
Total LPA time	441.1	368.9	494.1	51.4[a]	44.2	56.3
Locomotive LPA time	56.0	38.9	77.0	13.5[b]	10.3	18.0
Non-locomotive LPA time	367.3	320.4	431.3	86.5[b]	82.0	89.7
Total MVPA time	46.0	31.4	73.8	5.7[a]	4.0	8.4
Locomotive MVPA time	16.8	9.8	24.8	32.7[c]	26.1	53.4
Non-locomotive MVPA time	26.4	18.9	42.8	67.3[c]	46.6	73.9

Q1: first quartile; Q3: third quartile.
Sedentary: from 1 to 1.5 METs; LPA: from 1.6 to 2.9 METs; MVPA:3 METs or over.
LPA: light physical activity; MVPA: moderate-to-vigorous physical activity.
Locomotive: motion centering on the lower body such as walking.
Non-locomotive: motion centering on the upper body (non-walking).
[a]: % in wear time; [b]: % in total LPA; [c]: in total MVPA.

Table 4-1. Association between child-rearing assistance characteristics and physical activity time (minutes/day).

		Wearing time of triaxial accelerometer			*p*-value	Sedentary			*p*-value	LPA			*p*-value	MVPA			*p*-value
	n	Median	Q1	Q3		Median	Q1	Q3		Median	Q1	Q3		Median	Q1	Q3	
Number of grandchildren receiving care																	
1	11	873.0	756.3	918.5	.159	357.3	257.0	398.8	.750	437.8	403.0	486.0	.143	46.8	30.0	90.3	.606
2 to 3	25	828.5	765.5	895.4		357.0	294.5	421.5		385.8	339.8	496.4		43.8	32.6	62.8	
4 or over	12	892.1	859.1	955.7		357.1	275.9	424.9		476.6	459.2	509.3		55.3	33.3	127.6	
Age of main grandchildren receiving care																	
Under 3-year-old (range 0─11 years)	21	844.8	760.3	898.8	.525	350.5	277.1	397.0	.034	436.8	373.6	480.9	.846	54.5	35.1	83.4	.014
4–6-year-old (range 0─12 years)	13	840.8	769.6	913.3		340.8	264.4	376.0		442.5	327.8	514.0		52.5	36.9	144.4	
Over 7-year-old (range 1─17 years)	14	877.5	828.7	940.2		421.9	338.0	470.6		471.3	363.3	486.0		32.9	15.8	46.4	
Grandchildren attending daycare, preschool, or school																	
Yes	29	876.3	798.0	927.3	.202	341.8	269.0	396.4	.188	456.5	377.5	501.1	.121	53.0	35.8	89.1	.045
No	19	858.0	756.3	887.0		384.5	291.3	427.0		422.0	328.8	469.0		36.8	29.5	54.5	
Employed mother																	
Yes	30	868.4	747.1	911.6	.642	341.3	269.4	390.6	.069	455.3	372.1	499.4	.465	45.5	33.1	88.6	.406
No	18	844.8	788.4	916.0		395.3	322.5	452.4		437.8	357.3	476.4		45.3	29.8	58.4	
Frequency of contact with grandchild																	
Up to 3times/ week	27	863.8	792.3	909.3	.400	358.8	291.3	401.8	.596	442.5	381.3	499.3	.685	52.5	31.3	88.0	.519
Everyday	21	859.5	732.4	916.0		350.5	274.0	434.5		439.8	359.3	487.1		45.3	31.1	59.4	
Assistance pattern																	
Mainly sociocultural/ economical	22	873.5	767.3	932.6	.733	362.8	267.5	419.3	.695	423.6	362.9	488.1	.716	48.6	31.4	116.4	.508
Mainly physical	16	866.3	764.5	913.9		357.9	303.6	412.4		437.3	370.6	499.9		49.1	34.3	61.8	
Comprehensive child-rearing assistance	10	851.9	760.6	884.2		342.0	275.0	390.8		463.3	399.3	508.7		36.8	26.6	58.1	

Q1: first quartile; Q3: third quartile.
LPA: light physical activity; MVPA: moderate-to-vigorous physical activity. Sedentary: from 1 to 1.5 METs; LPA: from 1.6 to 2.9 METs; MVPA: 3 METs or over.

Table 4-2. Association between child-rearing assistance characteristics and physical activity (% wear/monitored time).

		Sedentary			*p*-value	LPA			*p*-value	MVPA			*p*-value
	n	Median	Q1	Q3		Median	Q1	Q3		Median	Q1	Q3	
Number of grandchildren receiving care													
1	11	42.6	33.8	44.7	.268	54.1	47.1	56.0	.519	5.3	3.5	12.1	.751
2 to 3	25	44.7	37.2	51.9		47.3	42.3	57.3		5.5	4.1	7.7	
4 or over	12	40.6	31.9	46.2		54.0	49.0	57.2		6.3	4.4	13.4	
Age of main grandchildren receiving care													
Under 3-year-old (range 0─11 years)	21	38.6	34.0	50.4	.152	50.7	45.6	56.1	792	6.6	4.5	10.7	.002
4–6-year-old (range 0─12 years)	13	39.5	30.7	47.0		55.3	42.2	59.5		7.0	5.4	17.1	
Over 7-year-old (range 1─17 years)	14	45.1	38.9	52.1		50.9	42.9	55.6		3.7	1.9	5.5	
Grandchildren attending daycare, preschool, or school													
Yes	29	38.8	34.0	45.2	.054	55.1	46.7	57.2	.116	6.6	5.1	10.7	.040
No	19	46.4	37.5	52.7		47.3	42.3	54.6		4.5	3.5	7.0	
Employed mother													
Yes	30	38.9	32.4	46.9	.132	53.7	46.7	56.8	.330	5.8	4.2	10.0	.259
No	18	45.5	37.2	52.3		50.1	43.1	56.1		5.3	3.4	6.7	
Frequency of contact with grandchild													
Up to 3times/ week	27	42.9	33.8	48.5	.942	50.1	45.4	56.3	.942	5.5	3.9	9.2	.611
Everyday	21	43.2	34.5	50.6		53.4	43.1	56.8		5.8	3.7	7.6	
Assistance pattern													
Mainly sociocultural/ economical	22	41.3	33.4	49.1	.789	50.4	43.5	55.9	.550	5.9	4.1	12.9	.559
Mainly physical	16	44.4	37.6	51.8		48.3	44.0	56.0		5.4	4.3	7.5	
Comprehensive child-rearing assistance	10	40.4	33.9	49.0		55.6	46.7	58.2		4.9	3.1	7.3	

Q1: first quartile; Q3: third quartile.
LPA: light physical activity; MVPA: moderate-to-vigorous physical activity. Sedentary: from 1 to 1.5 METs; LPA: from 1.6 to 2.9 METs; MVPA: 3 METs or over.

Table 5. Spearman's correlations between the number of types of assistance patterns and physical activity in grandmothers providing child-rearing assistance in each age group of grandchildren.

Number of types of assistance patterns in each age group	Physical activity time						
	Total sedentary	Total LPA	Locomotive LPA	Non-locomotive LPA	Total MVPA	Locomotive MVPA	Non-locomotive MVPA
Mainly under 3-year-old (n=21)							
Sociocultural/ economic	-.43	.08	.08	.05	-.12	-.40	-.06
Housework	-.05	-.01	.00	.16	-.32	-.40	-.28
Physical	.23	.11	-.10	.20	-.47*	-.50*	-.29
Accompanying	-.32	.33	.19	.28	.20	.13	.22
Mainly 4–6-year-old (n =13)							
Sociocultural/ economic	-.06	-.17	-.02	-.21	.09	-.24	.14
Housework	-.28	-.25	.17	-.38	.30	.16	.24
Physical	.05	-.27	-.17	-.22	-.52	-.49	-.27
Accompanying	.19	-.60*	.14	-.62*	-.06	.22	-.07
Over 7-year-old grandchildren (n=14)							
Sociocultural/ economic	.06	-.08	.03	.04	.18	.27	.14
Housework	-.18	.22	-0.2	.41	-.17	-.12	-.13
Physical	-.37	.54*	.15	.51	.25	.35	.16
Accompanying	.18	.29	.42	.25	.46	.33	.42

Significant correlation at * $p < 0.05$ (two-tailed).
LPA: Light Physical Activity; MVPA: Moderate-to-Vigorous Physical Activity.

Table 6-1. Spearman's correlations between physical activity and health-related quality of life in all participants.

Physical activity time (minutes/day)	Health-related quality of life（SF－8）							
	Physical Components				Mental Components			
	PF	RP	BP	GH	VT	SF	RE	MH
Total sedentary	.00	.09	-.11	.13	-.05	.16	-.05	-.17
Total LPA	.15	.04	.11	-.09	.10	-.01	.05	.18
Locomotive LPA	.31*	.12	.07	-.09	.03	-.14	.02	.18
Non-locomotive LPA	.05	-.03	.09	-.07	.08	.06	.06	.13
Total MVPA	.19	.32*	.19	.17	.21	-.11	-.01	.20
Locomotive MVPA	.11	.36*	.04	.16	.29*	-.14	-.02	.09
Non-locomotive MVPA	.21	.22	.20	.08	.06	-.07	.02	.21

Significant correlation at * $p < 0.05$ (two-tailed).
PF: physical functioning; RP: role physical; BP: bodily pain; GH: general health; VT: vitality; SF: social functioning; RE: role emotional; MH: mental health.
LPA: light physical activity; MVPA: moderate-to-vigorous physical activity.

Table 6-2. Spearman's correlations between physical activity and health-related quality of life in grandmothers providing child-rearing assistance in each age group of grandchildren.

Physical activity time in each age group of grandchildren (minutes/day)	Health-related quality of life（SF-8）							
	Physical Component				Mental Component			
	PF	RP	BP	GH	VT	SF	RE	MH
Mainly under 3-year-old (n=21)								
Total sedentary	.24	.35	-.07	.10	-.19	.36	.01	-.38
Total LPA	-.07	-.35	.46*	-.21	-.05	-.16	.01	.35
Locomotive LPA	.20	.06	.21	-.11	.04	-.13	.17	.35
Non-locomotive LPA	-.10	-.39	.44*	-.21	-.13	-.07	-.10	.25
Total MVPA	-.11	.06	.44*	.14	.30	-.17	-.03	.42
Locomotive MVPA	.07	.55*	.37	.36	.58**	.13	.13	.42
Non-locomotive MVPA	-.17	-.16	.26	.02	.03	-.21	.02	.41
Mainly 4-6-year-old (n =13)								
Total sedentary	-.44	-.07	-.10	.07	-.04	.20	.35	.18
Total LPA	.61*	.52	-.02	.08	.62*	.06	-.09	-.08
Locomotive LPA	.36	.13	-.14	-.16	.33	-.05	-.41	-.36
Non-locomotive LPA	.61*	.52	.10	.13	.59*	.26	.11	.05
Total MVPA	.36	.39	-.07	.53	.48	.12	-.19	.13
Locomotive MVPA	-.13	.07	-.43	.18	.32	-.24	-.19	-.15
Non-locomotive MVPA	.55	.32	.23	.47	.38	.12	-.29	.14
Over 7-year-old grandchildren (n=14)								
Total sedentary	.23	.32	.07	.37	.29	-.07	-.06	-.04
Total LPA	.21	.22	-.07	-.29	-.38	.24	.36	.21
Locomotive LPA	.57*	.30	.07	-.05	-.19	-.17	.08	.19
Non-locomotive LPA	-.15	-.09	-.20	-.17	-.33	.40	.28	-.06
Total MVPA	.32	.36	-.18	-.33	-.39	-.21	-.03	-.26
Locomotive MVPA	.20	.22	-.20	-.35	-.34	-.34	-.14	-.41
Non-locomotive MVPA	.35	.48	-.03	-.33	-.44	.07	.15	-.15

Significant correlation at ** $p < 0.01$, * $p < 0.05$ (two-tailed).

PF: Physical Functioning; RP: Role Physical; BP: Bodily Pain; GH: General health; VT: Vitality; SF: Social Functioning; RE: Role Emotional; MH: Mental Health.

LPA: Light Physical Activity; MVPA: Moderate-to-Vigorous Physical Activity.