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Relationship between participation in projects of incentives to promote walking and healthy aging among the older population: A four-year longitudinal study

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ABSTRACT

Objective: This study aimed to evaluate the association between the Yokohama Walking Point Program, which promotes walking through feedback on step counts and incentives, and the extension of healthy life expectancy.
Methods: A total of 4298 individuals aged over 65 years who responded to the 2013 and 2016 surveys and who were not certified as needing long-term care in 2016 were included in this study. The participants were categorized into "non-participation," "participation without uploading," and "participation with uploading" groups based on their involvement and uploading of pedometer data. The objective variable was the occurrence of long-term care certification and deaths over the subsequent four years. A modified Poisson regression model was applied, adjusting for 15 variables before project initiation.
Results: A total of 440 participants (10.2 %) were included in the "participation with uploading" group and 206 (4.8 %) in the "participation without uploading" group. Compared with "non-participation," the risk ratio was 0.77 (95 % confidence interval (CI): 0.59–0.99) for "participation with uploading" and 1.02 (95 % CI: 0.75–1.38) for "participation without uploading". In the sensitivity analysis censoring death as an inapplicable outcome and considering functional decline, participation with uploading showed a risk ratio of 0.79 (95 % CI: 0.60–1.04) for the likelihood of functional decline.
Conclusions: The use of pedometers and health point programs based on walking activity is associated with enhancing the health of older individuals participating in the program, representing a population-centric strategy targeting all citizens.

1. Introduction

Low physical activity increases the risk of developing diseases like type 2 diabetes, cardiovascular diseases, cancer, dementia, and depression (PAGAC, 2009). A systematic review found that increasing daily steps by 1000 led to a 6 %–36 % reduction in death and a 5 %–21 % reduction in cardiovascular diseases (Hall et al., 2020). In older population, fewer steps in their 70s are associated with high mortality rates (Yamamoto et al., 2018), and for those aged 70–89 years, fewer steps correlate with increased cardiovascular events (Cochrane et al., 2017).

According to a study of 1.9 million people, ~27.5 % of adults worldwide and over 30 % of Japanese adults are not sufficiently physically active (Guthold et al., 2018). Furthermore, physical activity is noted to be low among older adults (McPhee et al., 2016). Walking is classified as a moderate and familiar physical activity (PAGAC, 2009). The Ministry of Health, Labour and Welfare recommends 7000 steps for men and 6000 steps for women aged 65 years and over, whereas the average steps for men and women aged 65 years and over was 5744 steps and 4856 steps, respectively, in 2017 (National Institute of Health and Nutrition, 2019). Walking and physical activity in the older population are expected to reduce morbidity and mortality. However, actual walking levels are low.

Abbreviations: CI, Confidence interval; RR, Risk ratio; IADL, Instrumental activities of daily living; JAGES, Japan Gerontological evaluation study; YWPP, Yokohama walking point program.

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The effectiveness of pedometer use and financial incentives to motivate individuals to increase walking has been evaluated. A meta-analysis found that pedometer users take more steps than nonusers (Chaudhry et al., 2020). Individual step goals and step diaries may help increase physical activity (Hobbs et al., 2013). Pedometers are effective for goal setting, self-monitoring, and providing step count feedback (Harris et al., 2018).

Additionally, moderate financial incentives for aerobic activity are an effective and cost-effective way to increase physical activity among sedentary older adults (Finkelstein et al., 2008). Herein, participants were given $10 per week for exercising at least 15 min daily, with an additional $25 for each extra hour. Moreover, a short-term initiative using wearable trackers and health points for discounts on gym and hotel discounts resulted in a significant and sustained increase in physical activity, especially among the low-activity group. This effect persisted for two years and increased two years later (Hajat et al., 2019). Financial incentives for health behaviors encourage health behaviors, like smoking cessation, increased physical activity, and vaccination (Giles et al., 2014). Therefore, pedometers and financial incentives are expected to increase steps and physical activity.

In November 2014, Yokohama city, a Japanese city with a population of approximately four million, began walking point projects (Yokohama Walking Point Program [YWPP]), which incorporate the use of pedometers and financial incentives to encourage walking. Residents of Yokohama city can obtain a pedometer by filling out the prescribed application form and sending it to the Yokohama Health and Welfare Bureau. The postage, 610 yen (approximately five dollars), is paid by the resident. Points are awarded based on steps taken and those who achieve a certain number of points (equivalent to 5000 steps per day on average over three months) can win gift certificates by lottery. As of June 2022, 355,305 are in the YWPP, with 14,900 eligible for a 1000 yen gift certificate yearly. A previous study found YWPP participants increased walking time, improved motor function scores, and decreased depression scores compared with non-participants (Fujihara et al., 2020). Given that more steps are associated with less disease and death (Hall et al., 2020) and that depression increases disability survival (World Health Organization, 2017) and physical limitation (Stuck et al., 1999), participation in the YWPP is expected to reduce mortality and functional decline. Recently, the World Health Organization has prioritized promoting healthy aging and stated that being free of disease or infirmity is not a requirement for healthy aging, and developing and maintaining functional ability is a requirement for healthy aging (Rudnicka et al., 2020).

However, no previous studies have examined the effects of the YWPP on mortality or functional decline. YWPP participation is expected to increase walking due to pedometers and financial incentives. Thus, this study investigates whether the YWPP in Yokohama city promotes healthy aging among the older population. We hypothesized that in addition to YWPP participants, individuals who used pedometers and uploaded their step counts have a lower risk of functional decline and death.

2. Methods

2.1. Study population

Data for the analysis were from the Japan Gerontological Evaluation Study (JAGES) conducted in Yokohama city in 2013 and November 14–December 05, 2016, respectively (Kondo, 2016; Kondo and World Health Organization, 2018). This self-administered survey was administered via mail to people aged 65 years and over who were not certified as needing long-term care. Fig. 1 shows a flowchart of the analyzed participants. A total of 5111 persons responded to both the JAGES surveys in 2013 and 2016 (follow-up rate: 77.7 %), conducted before and after the YWPP began in October 2014. Of the 5111 persons, 4298 were included in the analysis, excluding those who showed functional decline until December 05, 2016 (n = 49 persons), responded that they "need care and assistance" (n = 230 persons) or did not respond this question (n = 294 persons) in the 2016 JAGES survey, and responded that they "do not go out alone using buses or trains" or did not respond this question (n = 240 persons) in 2016. Thus, those who could go out alone using buses or trains as of November–December 2016 and were able to participate in the YWPP were included in the analysis.

In addition to the JAGES data, two datasets from Yokohama city were integrated: first, pedometer data for YWPP participants; of 4298 valid respondents, data from 646 who participated in the YWPP on the

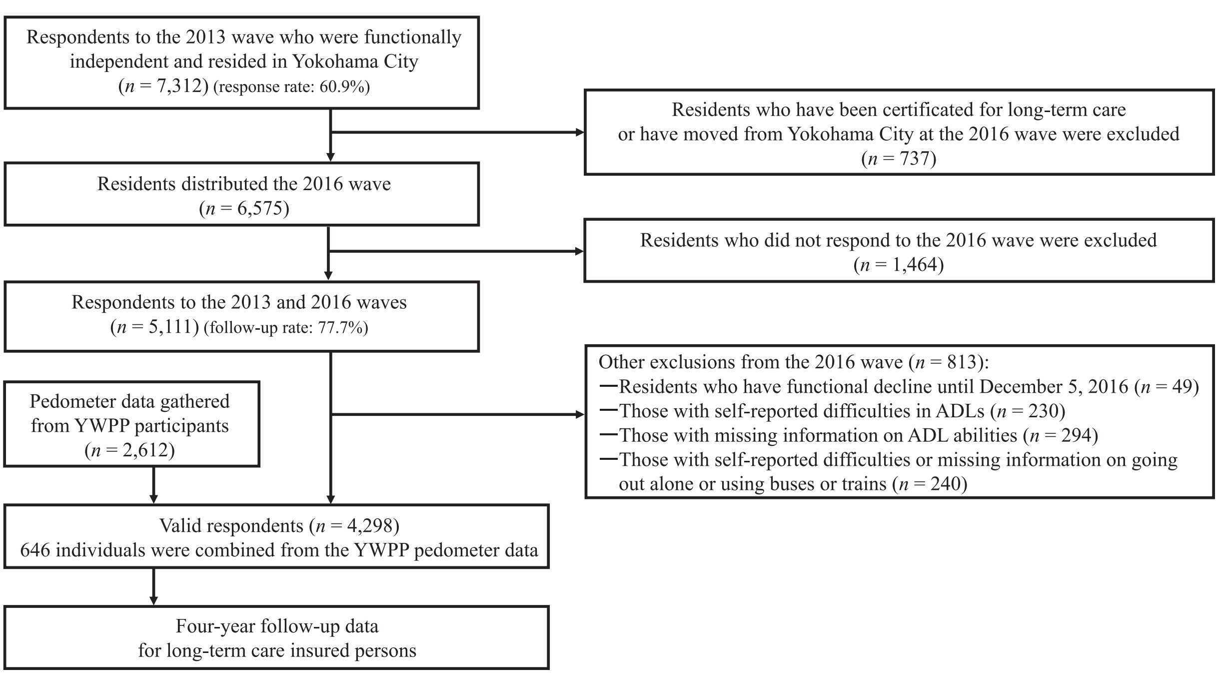

Fig. 1. Participant selection and recruitment flowchart (N = 4,298).
Abbreviations: ADL, activities of daily life; YWPP, Yokohama Walking Point Program.

December 05, 2016 were integrated from pedometer data, providing monthly step counts. Second, we used follow-up data for long-term care insured persons in Yokohama city from December 2016 to October 2020. From the long-term care insured data, we obtained information on respondents' status (functional decline, death, and relocation).

Ethical approval was obtained from the Nihon Fukushi University Ethics Committee (Approval: 10–05) for 2013, the National Center for Geriatrics and Gerontology (Application: 992–2), and the Chiba University Ethics Committee (Approval: 2493) for 2016. JAGES participants were informed that participation was voluntary, and returning the questionnaire indicated consent. Personal information was protected by deleting addresses/names, encrypting insured person numbers, and providing data in a form preventing individual identification.

2.2. Dependent variable: onset of functional decline or mortality

The study outcome was the onset of functional decline or all-cause mortality during the four-year follow-up (December 06, 2016–October 2020). Functional decline was identified by new certification for long-term care insurance, a standard nationwide in Japan (Tsutsui and Muramatsu, 2005). Data on long-term care insurance eligibility and premium imposition in Yokohama city were used to determine certification and death. Follow-up ceased if individuals relocated. These definitions used in previous epidemiological studies (Tamada et al., 2021). Assessing both functional decline and death as outcomes mitigates issues related to competing risks of death when solely focusing on functional decline. If both functional decline and death occurred, data until functional decline was measured. Sensitivity analysis was performed with functional decline as the only outcome.

2.3. Participation in the YWPP

The YWPP participants until December 05, 2016 were divided into two groups: one that received pedometer feedback and financial incentives for step counts and the other that did not upload step counts and was deemed ineligible for feedback and incentives. Using pedometer data showing the average monthly steps, those who participated in the YWPP and uploaded at least one step in the two months from November to December 2016 were defined as the "participation with uploading" group. To maintain consistency with the survey period, from November to December 2016 participation in the YWPP was used as explanatory variable. To avoid overestimation, reverse causation was mitigated by considering whether individuals who were able to participate in the YWPP actually did do during this period. Those who participated in the project but did not upload any steps were defined as the "participation without uploading" group, and those who did not participate were defined as the "non-participation" group. In the sensitivity analysis, the "participation with uploading" and "participation without uploading" groups were combined into one "participation" group.

2.4. Confounding factors

A total of 15 biomedical, psychological, and social factors that may influence YWPP participation and care certification were identified from the 2013 JAGES survey data before YWPP initiation, as outlined in a prior study (Fujihara et al., 2020). Confounders included sex, age, annual equivalized income, educational attainment, household, occupational status, self-reported medical conditions, self-rated health, body mass index, smoking, alcohol consumption, walking time, instrumental activities of daily living (IADL), depression, and participation in groups. IADL was measured using the five-item Tokyo Metropolitan Institute of Gerontology Index of Competence (Koyano et al., 1991). Respondents scoring less than four were classified as dependent, while those scoring five were considered independent (Fujihara et al., 2019). Depression was assessed using the 15-item geriatric depression scale (Yesavage et al., 1982). Social participation was defined as participation at least once a week in one of the following groups: hobbies, sports, volunteer, study or cultural groups, and activities to teach skills or share experiences with others.

2.5. Statistical analysis

Potential bias due to missing data was addressed. Data were assumed to be missing at random, indicating that the missing mechanism depends on the observed data. Multiple imputations were performed to impute incomplete variables (van Ginkel et al., 2020). A total of 20 imputed datasets were created, and the effect estimates were combined using Rubin's rule (Rubin, 1996).

The characteristics of the "non-participation," "participation without uploading," and "participation with uploading" groups before the start of the YWPP were tabulated. The $\chi2$ test was not performed because statistical testing of variable distributions is not recommended (Hayes-Larson et al., 2019). Walking time per day before and after the start of the YWPP was calculated using the JAGES survey data in 2013 and 2016. Average daily step counts per month in the "participation with uploading" group were determined using the pedometer data, and the change in steps from December 2016 to October 2020 was calculated using a linear mixed model. Repeated measures of walking steps (level 1) were nested within participants (level 2). Assuming zero covariance between measurements and no correlation between different random effects, we used a diagonal variance–covariance structure for repeated measures and a variance components variance–covariance structure for random effects. This model included fixed intercept with fixed time effects and random intercept with random slope of time. No other predictors were present except time as level 1 predictor.

As the Kaplan–Meier curve (Supplementary Fig. 1) and the Schoenfeld residual test do not allow for the assumption of proportional hazards (Kuitunen et al., 2021), we calculated risk ratios (RRs) and 95 % confidence intervals (CIs) for the incidence of functional decline or death using modified Poisson regression models (Cummings, 2009) adjusting for all covariates excluding relocated people. The analysis was performed by increasing the follow-up period every one year: <one year, <two years, <three years, and the total follow-up period (3.83 years). When the outcome incidence is not rare in the study population (>10 %), a modified Poisson regression analysis was performed (Zou, 2004), as adjusted odds ratios from logistic regression cannot approximate the risk ratio (Zhang and Yu, 1998). All point estimates are pooled results from 20 imputed datasets.

In the sensitivity analysis, the association between YWPP participation and functional decline was first analyzed, with those who died censored at that time for outcomes not applicable. Second, the analysis was performed on two groups, participation and non-participation, without considering whether they uploaded the data. Third, the RRs for "participation with uploading" were calculated by taking "participation without uploading" as a reference.

Statistical analysis was performed using Stata 16.0 software (Stata Corp. LLC, College Station, TX, USA), with significance set at 5 %.

3. Results

Of the 4298 participants, 3652 (85.0 %) were non-participants in the YWPP until December 05, 2016, and 646 (15.0 %) did, divided into the "participation without uploading" (n = 206, 4.8 %) and "participation with uploading" (n = 440, 10.2 %) groups. During the observation period, 53 (1.2 %) left Yokohama city. The incidence of functional decline or death after approximately four years was 18.9 % (690) for non-participants, 15.5 % (32) for participants without uploading, and 11.4 % (50) for participants with uploading.

Table 1 shows the characteristics of the non-participation, participation without uploading, and participation with uploading groups. The characteristics of the participants with uploading were as follows: younger, equivalent income of 2–3.99 million yen, high educational

Table 1
Characteristics of older people in Yokohama City categorized according to their participation or non-participation in Yokohama Walking Point Program (baseline survey in 2013).

		Total (n = 4298)	Non-participation (n = 3652)		Participation without uploading (n = 206)		Participation with uploading (n = 440)	
		n	n	%	n	%	n	%
Age (years)	65–69	1371	1141	31.2	70	34.0	160	36.4
	70–74	1466	1271	34.8	79	38.3	170	38.6
	75–79	942	821	22.5	40	19.4	81	18.4
	80–84	415	377	10.3	14	6.8	24	5.5
	≥85	104	96	2.6	3	1.5	5	1.1
Sex	Female	2212	1875	51.3	115	55.8	222	50.5
	Male	2086	1777	48.7	91	44.2	218	49.5
Annual equivalized income (million yen)	Low (<2.0)	1374	1176	32.2	61	29.6	137	31.1
	Middle (2.0–3.9)	1792	1482	40.6	98	47.6	212	48.2
	High (≥4.0)	625	543	14.9	30	14.6	52	11.8
	Missing	507	451	12.3	17	8.3	39	8.9
Educational attainment (years)	<10	802	711	19.5	29	14.1	62	14.1
	10–12	1733	1477	40.4	86	41.7	170	38.6
	≥13	1696	1406	38.5	85	41.3	205	46.6
	Missing	67	58	1.6	6	2.9	3	0.7
Household	Living alone	559	505	13.8	15	7.3	39	8.9
	Living with family	3586	3009	82.4	186	90.3	391	88.9
	Others	43	37	1.0	3	1.5	3	0.7
	Missing	110	101	2.8	2	1.0	7	1.6
Occupational status	Employed	996	879	24.1	44	21.4	73	16.6
	Retired/not employed	2695	2238	61.3	139	67.5	318	72.3
	Never employed	398	350	9.6	16	7.8	12	2.7
	Missing	209	185	5.1	7	3.4	17	3.9
Self-reported medical conditions	Illness	3197	2715	74.3	154	74.8	328	74.5
	No illness	842	713	19.5	42	20.4	87	19.8
	Missing	259	224	6.1	10	4.9	25	5.7
Self-rated health	Excellent	717	585	16.0	43	20.9	89	20.2
	Good	3021	2573	70.5	147	71.4	301	68.4
	Fair	401	361	9.9	11	5.3	29	6.6
	Poor	34	30	0.8	0	0.0	4	0.9
	Missing	125	103	2.8	5	2.4	17	3.9
Body mass index	Underweight (<18.5)	315	277	7.6	6	2.9	32	7.3
	Normal (18.5–24.9)	3096	2607	71.4	163	79.1	326	74.1
	Overweight (≥25)	779	671	18.4	35	17.0	73	16.6
	Missing	108	97	2.7	2	1.0	9	2.0
Smoking	Current smoker	394	369	10.1	13	6.3	12	2.7
	Past smoker	756	630	17.3	36	17.5	90	20.5
	Never smoked	3103	2614	71.6	154	74.8	335	76.1
	Missing	45	39	1.1	3	1.5	3	0.7
Alcohol consumption	Current drinker	1901	1595	43.7	91	44.2	215	48.9
	Past drinker	201	180	4.9	9	4.4	12	2.7
	Never drank	2155	1842	50.4	104	50.5	209	47.5
	Missing	41	35	1.0	2	1.0	4	0.9
Walking time (minutes/day)	<30	642	577	15.8	26	12.6	39	8.9
	30–59	1798	1533	42.0	90	43.7	175	39.8
	60–89	999	817	22.4	44	21.4	138	31.4
	≥90	816	687	18.8	44	21.4	85	19.3
	Missing	43	38	1.0	2	1.0	3	0.7
Instrumental activities of daily living	Not decline	1786	1456	39.9	108	52.4	222	50.5
	Decline	2349	2046	56.0	95	46.1	208	47.3
	Missing	163	150	4.1	3	1.5	10	2.3
Depression	No	3001	2505	68.6	159	77.2	337	76.6
	Mild	590	522	14.3	20	9.7	48	10.9
	Moderate to severe	156	143	3.9	3	1.5	10	2.3
	Missing	551	482	13.2	24	11.7	45	10.2
Participation in groups	Participation	1513	1196	32.7	95	46.1	222	50.5
	Non-participation	2110	1872	51.3	80	38.8	158	35.9
	Missing	675	584	16.0	31	15.0	60	13.6

attainment, living with a family member, retired or not working, good subjective health, not smoking, current drinker, long walking time, good activity capacity, no tendency toward depression, and participation in groups. Of individuals aged 65–69 years, 36.4 % were in the participation with uploading group, whereas 31.2 % were in the non-participation group. The characteristics, including employed, body mass index of 18.5–25, smoker, never drank, short walking time, good activity ability, and no social participation, were more common among participants without uploading than those with uploading.

Supplementary Table 1 shows the relationship between YWPP participation status and daily walking hours in 2013 and 2016 before and after the YWPP began. The "participation with uploading" group had a longer average walking time in 2016 than in 2013. Conversely, the "participation without uploading" and "non-participation" groups had a shorter average time in 2016 than in 2013.

After adjustment for potential 15 confounders, multivariate analysis found a lower probability of functional decline or death during the follow-up period in the participation with uploading group than the non-participation group (3.83 years; RR = 0.77, 95 % CI: 0.59–0.99) both within three years and within two years (Table 2). However, we found no significant difference between the probabilities of functional decline or death of the participation without uploading and non-participation groups (RR = 1.02, 95 % CI: 0.75–1.38) (Table 2).

Table 3 shows the sensitivity analysis in which death was censored as an inapplicable outcome, such that the outcome measure was the probability of functional decline only. In the participation with uploading group, the RR for functional decline over the entire period were 0.79 (95 % CI: 0.60–1.04). The three-, two-, and one-year RRs were 0.63 (95 % CI: 0.44–0.90), 0.41 (95 % CI: 0.23–0.73), and 0.36 (95 % CI: 0.13–0.96), respectively. These results were similar to those found in the main analysis, where the outcome was functional decline or death.

Supplementary Table 2 presents analysis results for participation and non-participation groups, disregarding step uploads. Functional decline and mortality are presented as objective variables (Table above), and functional decline is presented as an objective variable (Table below). Significant differences in the rate of functional decline and death were observed between participants and non-participants after both two and three years of follow-up, but the results were inconsistent. The RRs of the participation with uploading group were calculated using the participation without uploading group as the reference (Supplementary Table 3). The only significant difference found between the participation with uploading and participation without uploading groups was for the two-year follow-up.

Average daily step counts per month were recorded for 440 pedometer users from December 2016 to October 2020. Supplementary Fig. 2 shows point estimates and 95 % CIs for each month, accounting for any missing or dropout data. Fixed and random effects of month for average daily step counts per month are shown in Supplementary Table 4. Over 47 months, the average step count decreased by 32 steps per month.

4. Discussion

This is the first study to investigate the relationship between participation in the YWPP and the occurrence of long-term care and death. The analysis considered the characteristics of the participation and non-participation groups before the start of the YWPP. Participation with uploading step counts showed significantly less long-term care certification and death at approximately four years than non-participation (RR = 0.77). However, no significant difference was observed between participation without uploading and non-participation. A previous study showed that municipality-led incentivized health promotion programs in Japan increased step counts after participation (Chujiki et al., 2023). Here, increased step counts among YWPP participants with uploading were probably associated with less need for long-term care and fewer deaths. No previous studies have examined these specific associations.

4.1. Mechanisms of the YWPP

The YWPP correlated with lower rates of long-term care certification and mortality, largely due to two key factors. First, Pedometers facilitated self-monitoring of step counts, presenting data in a clear, user-friendly format that allowed users to track their entire step history upon uploading, thus encouraging increased step counts (Chaudhry et al., 2020; Sullivan and Lachman, 2016). Second, financial incentives motivated participants. This is consistent with previous research indicating that health points from wearable trackers significantly increase physical activity, especially among less active individuals, sustaining this effect over two years (Hajat et al., 2019).

4.2. Factors correlated with the YWPP

Correlations have been found among YWPP participants between those who upload and both engagement in self-monitoring of step count data and the use of financial incentives (Chaudhry et al., 2020; Giles et al., 2014). Although, from the study's data we could not identify the uploaders who actually benefited from the financial incentives, a certain percentage of uploaders received gift certificates. Conversely, non-uploaders did not benefit from self-monitoring and financial incentives. Notably, herein, participation with uploading had a healthy, longer life expectancy, while that of participation without uploading did not differ from non-participation.

A 4-week randomized controlled trial reported that using pedometers with financial rewards increased aerobic exercise duration (Finkelstein et al., 2008). Furthermore, wearable-based and reward-driven digital health interventions have shown to increase the time spent on preventive activities, reduce nonemergent emergency department admissions, and reduce healthcare costs (Zaleski et al., 2023). The reduction in functional decline and death observed herein was partly associated with the increase in aerobic exercise due to the time spent walking, as well as other YWPP activities aimed at preventing functional decline in older adults.

A systematic review of financial incentives and physical activity showed that rewards for achieving physical activity goals were associated with increased physical activity, whereas unconditional rewards for going to the gym or attending walking sessions were not (Barte and Wendel-Vos, 2017). Combining YWPP participation with a reward incentive for achieving the former goal appeared more effective in this regard. In the nine out of 12 trials with post-intervention step count data, incentives were associated with increases in the mean daily step count (Mitchell et al., 2020). Financial incentives are strongly associated with smoking cessation within six months, though their effect diminishes over time (Chaudhry et al., 2020; Giles et al., 2014). Similarly, this study observed a gradual monthly decrease of 32 steps in participants who uploaded data (Supplementary Table 4). Moreover, the RRs of functional decline and mortality among YWPP participants compared with non-participants increased with longer follow-up (Table 2). Additionally, higher financial incentives correlate with increased smoking cessation rates (Giles et al., 2014). Although we found that even lottery incentives are associated with better outcomes, the relationship between incentives and improved results may be further strengthened by increasing the incentives.

Table 2
RRs for functional decline and death according to YWPP participation status considering uploading among older people in Yokohama City based on twenty imputed datasets (2016–2020 cohort data).

YWPP participation status	Within one year of follow-up			Within two years of follow-up			Within three years of follow-up			Within the entire follow-up period (3.83 years)		
	RR	95 % CI	p[a]	RR	95 % CI	p[a]	RR	95 % CI	p[a]	RR	95 % CI	p[a]
Non-participation	1.00			1.00			1.00			1.00		
Participation without uploading	1.28	0.62–2.63	0.503	1.17	0.75–1.84	0.492	0.95	0.66–1.38	0.797	1.02	0.75–1.38	0.919
Participation with uploading	0.46	0.20–1.03	0.058	0.42	0.24–0.72	0.002	0.62	0.45–0.86	0.005	0.77	0.59–0.99	0.044

Abbreviations: RR, risk ratio; CI, confidence interval; YWPP, Yokohama Walking Point Program.
[a] Statistical analyses were performed using adjusted Poisson regression analysis to calculate p-values.

Table 3
RRs for functional decline according to YWPP participation status considering uploading among older people in Yokohama City based on twenty imputed datasets (2016–2020 cohort data).

YWPP participation status	Within one year of follow-up			Within two years of follow-up			Within three years of follow-up			Within the entire follow-up period (3.83 years)		
	RR	95 % CI	p[a]	RR	95 % CI	p[a]	RR	95 % CI	p[a]	RR	95 % CI	p[a]
Non-participation	1.00			1.00			1.00			1.00		
Participation without uploading	1.58	0.76–3.28	0.217	1.30	0.81–2.09	0.270	1.07	0.72–1.58	0.747	1.15	0.83–1.59	0.392
Participation with uploading	0.36	0.13–0.96	0.040	0.41	0.23–0.73	0.003	0.63	0.44–0.90	0.010	0.79	0.60–1.04	0.089

Abbreviations: RR, risk ratio; CI, confidence interval; YWPP, Yokohama Walking Point Program.
[a] Statistical analyses were performed using adjusted Poisson regression analysis to calculate p-values.

4.3. *Strategies for promoting and increasing awareness of the YWPP to enhance its impact*

To enhance the YWPP's impact, targeted strategies are necessary for engaging non-participants, especially those who are older, less educated, live alone, employed, have poor self-rated health, smoke, abstain from alcohol, or engage in little physical activity. In a previous study, ways to get more people involved included the authors focusing on simple step activities, attractive incentives, such as free fitness trackers, wide range of e-vouchers for lifestyle retailers, food and, drink outlets, and supermarkets, versatile activity tracking modes, and widespread local roadshows and advertising in commonly accessed places (Yao et al., 2022). Multicomponent interventions are said to be important for increasing physical activity and social participation in older adults. For example, efforts that combine exercise sessions with additional social activities (Tcymbal et al., 2022). Older adults and people living alone are more likely to participate in community gathering places i.e., Japan's main strategy for preventing functional disability among older adults (Ide et al., 2023). Moreover, those initially less active have shown greater increases in steps, indicating potential for broader benefits through expanded participation (Chijiki et al., 2023). As cities with high participation in social activities and outdoor engagement among older residents tend to have a longer healthy life expectancy (Rueda-Salazar et al., 2021). The widespread adoption of the YWPP may contribute to the development of healthier cities.

4.4. *Strength and limitations*

This study objectively determined not only whether the participants participated in the YWPP but also whether they benefited from the pedometer and financial incentives. In the subjective evaluation, healthier and more positive thinkers might be more likely report pedometer use (Naseem and Ruhi, 2010), potentially leading to significant differences. Therefore, this study conducted an objective evaluation using pedometer data for YWPP participants. Furthermore, comparisons between groups were adjusted for background factors, such as demographics and health status in 2013, comprehended before YWPP initiation.

This study has a few limitations. First, the target population was limited to those who responded to the self-administered survey at two time points, possibly biasing toward relatively healthier individuals. Second, this study was conducted in an urban municipality, targeting older people not certified for long-term care, limiting generalizability regarding to areas with different walkability. Third, a larger proportion of participants had higher educational background, suggesting a need to evaluate the YWPP's effectiveness on those prone to functional decline (Takeda et al., 2010) and its impact on health disparities.

5. Conclusions

Participants who participated in the YWPP, used a pedometer, and uploaded the data were significantly less likely to require support or long-term care or to die than those who did not participate in the YWPP. The use of pedometers and health point programs based on the amount of walking is useful for improving the health of older people who participate in the program as a population approach targeting all citizens.

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CRediT authorship contribution statement

Gemmei Iizuka: Writing – original draft, Methodology, Data curation, Conceptualization. **Taishi Tsuji:** Writing – review & editing. **Kazushige Ide:** Writing – review & editing. **Katsunori Kondo:** Writing – review & editing, Resources, Investigation, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2024.108125.

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