Patterns of Physical Activity and Their Relationship With Depression Among Community-Dwelling Older Adults in Shanghai, China: A Latent Class Approach

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Research Article

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Abstract

Background: Few studies have explored patterns of physical activity (PA) and examined their relationship with depression among community-dwelling older adults. An understanding of PA patterns in this population may have implications for the development of community interventions, both to support beneficial patterns of PA and to target specific latent classes of community-dwelling older adults.

Methods: We conducted a cross-sectional survey study in the Minhang district, Shanghai, China, in August 2019, and used a self-administered questionnaire to collect data through home visits. The total sample included 2,525 older adults. This study used the Physical Activity Scale for the Elderly (PASE) to assess the quantity of PA in older adults. Depression was evaluated with the Geriatric Depression Scale (GDS). Latent class analysis (LCA) was used to identify subpopulations by shared item response patterns. Logistic regressions were performed to estimate the relationship between PASE score, patterns of PA, and depression.

Results: Four latent classes were identified: “domestic types,” “athletic types,” “gardening/caring types,” and “walkers.” PASE scores and latent class predicted depression independently. Older adults who were the most active (PASE quartile: 75–100%) and the athletic types had the strongest significant association with depression (relative risk = 0.21, 95% CI: 0.06–0.68), followed by those who were the most active (PASE quartile: 75–100%) and the walkers (relative risk = 0.28, 95% CI: 0.14–0.57) when compared with older adults with the least activity (PASE quartile: 0–25%) and domestic types. Older adults who were the most active (PASE quartile: 75–100%) and the gardening/caring types were most likely to be depressed (relative risk = 1.66, 95% CI: 1.03–2.69).

Conclusion: This study suggests an overall protective effect of physical activity on depression among community-dwelling older adults. Population-level intervention should combine being athletic with other patterns of physical activity. To develop individual-level tailored interventions, more attention should be paid to older adults who are highly engaged in caring for others.

Background

Depression is one of the most prevalent mental disorders in later life that has a high risk of disability worldwide [1–3]. Depression and depressive symptoms are attracting considerable interests due to their related consequences, including increased chronic disease [4], suicide and non-suicide mortality [5], and high disease burden [6].

Physical activity (PA) may be beneficial in reducing the risk of depression, but studies have reported mixed results [7–14]. Previous studies have focused on the quantity or levels of PA and their relationship with depression in older people [15, 16]. Recent research has shown that different patterns of PA may have an influence on depression, as some types of PA may be protective against depression for older adults while others may not [17, 18].

Patterns of PA include work-related, domestic-related, and leisure-time activity [19]. It is challenging to compare the benefits of different patterns of PA as they are highly correlated; for example, older adults who do domestic work may be more likely to garden.[17] Latent class analysis (LCA) provides a person-centered approach for identification of patterns of PA and has been used in several studies [22–24]. To our knowledge, there has been no study exploring patterns of PA using LCA and examining the relationship between latent classes of PA and depression among Chinese community-dwelling older adults. Our study may provide implications for developing community interventions, both to support some patterns of PA and to target specific latent classes of community-dwelling older adults.

The purposes of this study were to: (1) identify the patterns of PA among Chinese community-dwelling older adults; (2) examine the independent contribution that quantity and patterns of PA have on depression among Chinese community-dwelling older adults; and (3) explore the joint effects of levels and patterns of PA on depression among Chinese community-dwelling older adults.

Methods

Participants

A cross-sectional survey study was conducted in the Minhang district, Shanghai, China, in August 2019. We used a self-administered questionnaire to collect data through home visits. The sample was randomly selected from the census database of older adults in the Minhang district, Shanghai. Inclusion criteria were: 1) age ≥ 60; 2) being community-dwelling; and 3) being able to communicate and willing to consent and participate. Exclusion criteria were as follows: 1) inability to understand and follow the assessment protocol of the study; and 2) having major neurocognitive disorders. The total sample included 2,525 older adults. This research protocol was approved by the Ethical Review Board of Fudan University, and informed written consent was obtained before data collection.

Measures

Assessment of physical activity

This study used the Physical Activity Scale for the Elderly (PASE) to assess the quantity of PA in older adults. All participants were asked to recall past-week leisure time activity, household activity, and paid or volunteer work. Items included engagement in walking, sports and recreation, muscle-strengthening and endurance exercises, housework, home repair, gardening, yard work, caring for others, and paid or volunteer work [25]. For leisure time activity, individuals responded “never,” “rarely,” “sometimes,” or “often.” The average time spent on each type of activity per day was also recorded. For household activity and paid or volunteer work, participants responded “yes” or “no.” Information on the hours and types of work involved was also gathered. Each PASE item had a weight value determined by the original authors of the measurement tool [26]. The overall PASE score was calculated by multiplying the amount of time spent and participation by the PASE weight value, and then summing for a total score. The PASE scores ranged from 0 to 500 or more. The higher the scores, the higher the PA levels. PASE scores have been

validated against several objective activity measures, including accelerometers and doubly labeled water [27, 28]. There is evidence supporting the validity and reliability of the Chinese version of the PASE [29].

Latent class analysis

Indicators of activity types were developed from PASE items and two modifications were made based on the study of Mooney et al. [30] First, to retain information regarding activity duration in categorical variables used by LCA, we recoded PASE items indicating the duration of activity (walking, sports and recreation, and muscle-strengthening exercises) into dichotomous variables indicating ever having engaged (> 0 min/day on any day) in the activity and often engaging (> 30 min/day on average). Second, to increase the homogeneity of the classes that were engaged in sport and recreation activities, we combined all sport/recreation categories for analysis. Finally, a total of 12 items were used in the LCA model including the following items: ever does sports, ever exercises, ever walks, often-sports, often-exercises, often-walks, light housework, heavy housework, home repairs, yard care, outdoor gardening, and caring for others.

Assessment of depression

The 30-item Geriatric Depression Scale (GDS), used worldwide, was utilized to assess the depression symptoms of the participants [31]. Participants were asked to respond “yes” or “no” to each item. Summary scores ranged from 0 to 30. A well-validated cutoff point ≥ 11 was used to define depression [32]. The validity and reliability of the GDS-30 has been tested in China and also used in Chinese older adults [33].

Sociodemographic factors and physical health status

Participants’ sociodemographic characteristics were measured as follows (see the supplementary file): (1) age (categorized as 60–74 = 1, 75–84 = 2, ≥ 85 = 3); (2) sex (male = 0, female = 1); (3) marital status (married = 1, others = 0); (4) educational background (illiteracy = 1, primary school = 2, middle school = 3, high school = 4, college and more = 5); (5) income (≤ 2000 = 1, 2001–5000 = 2, ≥ 5001 = 3); and (6) living arrangements (living alone = 1, live with spouse only = 2, live with spouse and children = 3, live with others = 4).

Physical health status was assessed by two variables (see the supplementary file): (1) having any chronic disease (Yes = 1, No = 0), and (2) self-rated health. To measure self-rated health, each participant was asked, “How would you describe your current health status?” The responses ranged from 1 to 5 indicating excellent to poor health. We reverse coded self-rated health to make higher values indicate better health so that the results were easier to interpret.

Statistical analysis

Descriptive statistics were used to summarize sample characteristics. LCA was used to identify subpopulations (latent classes) by shared item response patterns. Logistic regressions were performed to

estimate the relationship between PASE score, patterns of PA, and depression. In multivariate analyses, levels and patterns of PA were included simultaneously in the same model to estimate their independent contributions to depression risk. LCA models were conducted in Mplus version 8.0 and all subsequent analyses were performed using Stata SE version 15.1(StataCorp., College Station, TX, USA).

Results

Participant characteristics

Table 1 presents the participants' characteristics. The majority of the sample was age 60–74 years (*N* = 1,829, 72.4%), 55.8% (*N* = 1,410) were female, and 83.6% (*N* = 2,111) were married. The average PASE score was 119.34 (SD = 41.93). A minority (13.43%) reported depression.

Table 1
Sample characteristics (N = 2,525)

Characteristics	N (%) or mean ± *SD*
Age group (years)	
60–74	1,829 (72.4)
75–84	503 (19.9)
≥ 85	193 (7.7)
Gender	
Male	1,115 (44.2)
Female	1,410 (55.8)
Education	
Illiteracy	194 (7.7)
Primary school	463 (18.3)
Middle school	901 (35.7)
High school	658 (26.1)
College and more	309 (12.2)
Marital status	
Married	2,111 (83.6)
Others	414 (16.4)
Income (Yuan)	
≤ 2000	327 (12.9)
2001–5000	1,757 (69.6)
≥ 5001	441 (17.5)
Living arrangements	
Living alone	199 (7.9)
Live with spouse only	1,381 (54.7)
Live with spouse and children	459 (18.2)
Live with others	486 (19.2)
Self-rated health	2.90 ± 0.99
Chronic disease	

Characteristics	N (%) or mean ± *SD*
Yes	1,652 (65.4)
No	873 (34.6)
PASE score	119.34 ± 41.93
GDS score	
< 11	2,186 (86.57)
≥ 11	339 (13.43)

Patterns of physical activity: a four-class model

Table 2 presents results from the LCA. Five latent class models were created, specifying latent class counts from two to six. According to recommendations of model selection in LCA [34, 35], we chose a four-class solution as the best fitting model. A four-class model showed the highest entropy, representing the highest certainty of classification. The decrease in Akaike information criteria (AIC), Bayesian information criteria (BIC), and sample-size adjusted BIC (aBIC) also supported the four-class model, as the five-class model showed a relatively smaller decrease in these indices. Both the Lo-Mendell-Rubin likelihood ratio test (LMR) and the bootstrapped likelihood ratio test (BLRT) confirmed the significance of the four-class solution ($p < 0.05$). Moreover, the four-class model was interpretable and reasonably well defined (Table 3). The final latent classes were as follows: 1) older adults who reported housework but little other activities (29.7% of participants, “domestic types”); 2) older adults who were physically active, especially engaging in sports (11.7% of participants, “athletic types”); 3) older adults who reported yard care, gardening and caring for others but little other activities (20.9% of participants, “gardening/caring types”); and 4) older adults who reported walking and some housework (37.7% of participants, “walkers”). Figure 1 presents the proportion of physical activities engagement of community-dwelling older adults in the condition of latent class assignment.

Table 2
LCA model fit statistics

Classes	AIC	BIC	aBIC	Entropy	LMR	BLRT
2	24642.702	24788.552	24709.121	0.883	< 0.0001	< 0.0001
3	23673.848	23895.54	23774.804	0.895	< 0.0001	< 0.0001
4	23368.236	23665.77	23503.729	0.915	< 0.0001	< 0.0001
5	23166.994	23540.37	23337.025	0.868	< 0.0001	< 0.0001
6	23021.524	23470.741	23226.092	0.784	0.3153	< 0.0001

Note: AIC, Akaike information criteria; BIC, Bayesian information criteria; aBIC, sample-size adjusted BIC; LMR, *p*-value for the Lo-Mendell-Rubin likelihood ratio test; BLRT, *p*-value for the bootstrapped likelihood ratio test.

Table 3
Proportion of 2,525 Shanghai residents aged ≥ 60 years within each latent class assignment who reported conducting each form of physical activity

Activity	Domestic types	Athletic types	Gardening/Caring types	Walkers
Ever does sports	8	100	7	8
Ever exercises	0	1	0	0
Ever walks	77	95	69	100
Sports ≥ 30 min/day	0	87	1	0
Exercises ≥ 30 min/day	0	0	0	0
Walking ≥ 30 min/day	0	65	25	100
Light housework	99	97	51	99
Heavy housework	86	75	5	86
Home repairs	31	29	1	28
Yard care	7	19	92	6
Outdoor gardening	22	23	79	32
Caring for others	29	35	79	40
PASE score, M (95% CI)	93.6 (91.3,95.9)	144.5 (137.6,151.3)	132.0 (129.7,134.3)	124.8 (122.4,127.3)
Percentage of cohort	29.7	11.7	20.9	37.7

Relationship between PASE scores, latent activity classes, and depression

Physical activity classes were predictive of depression: 26.9% of the gardening/caring class was depressive, compared with 13.3%, 3.4%, and 9.2% of the domestic types, athletic types, and walkers, respectively (χ^2 test, $p < 0.001$). In multivariable models (Table 4), PASE scores and latent class predicted depression independently, suggesting that patterns of PA provided information above and beyond PASE score alone (PASE scores, $r^2 = 0.169$; latent class, $r^2 = 0.178$; both, $r^2 = 0.182$).

Table 4
Logistic regression models showing the relationship between PASE score, patterns of PA, and depression (n = 2525)

	Model 1	Model 2	Model 3
Variable	OR (95% CI)	OR (95% CI)	OR (95% CI)
PASE score	0.99** (0.99–0.998)		0.99* (0.99–0.999)
Patterns of PA (Domestic types as reference)			
Athletic types		0.27***(0.14–0.53)	0.35**(0.17–0.71)
Gardening/Caring types		1.25 (0.89–1.75)	1.55* (1.06–2.26)
Walkers		0.73 (0.53–1.01)	0.88 (0.62–1.24)
Age group (years, 60–74 as reference)			
75–84	2.18***(1.61–2.96)	1.93***(1.41–2.64)	1.93***(1.41–2.64)
85+	3.67***(2.45–5.50)	2.77***(1.80–4.28)	2.72***(1.76–4.20)
Female	1.10 (0.84–1.45)	1.16 (0.88–1.53)	1.16 (0.88–1.52)
Education (illiteracy as reference)			
Primary school	0.87 (0.56–1.34)	0.87 (0.56–1.35)	0.89 (0.57–1.38)
Middle school	0.77 (0.50–1.20)	0.82 (0.52–1.27)	0.81 (0.52–1.27)
High school	0.69 (0.43–1.12)	0.72 (0.44–1.16)	0.73 (0.45–1.19)
College and more	0.69 (0.38–1.23)	0.77 (0.43–1.39)	0.75 (0.42–1.36)
Married	1.25 (0.82–1.92)	1.39 (0.91–2.13)	1.32 (0.87–2.02)
Income (< = 2000 yuan/month as reference)			
2001–5000	0.57**(0.41–0.80)	0.57**(0.40–0.80)	0.58**(0.41–0.82)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

	Model 1	Model 2	Model 3
5001+	0.38***(0.23–0.63)	0.37***(0.22–0.62)	0.38***(0.23–0.63)
Living arrangements (living alone as reference)			
Live with spouse only	0.47**(0.27–0.82)	0.45**(0.26–0.78)	0.45**(0.26–0.78)
Live with spouse and children	0.53*(0.29–0.97)	0.51*(0.28–0.94)	0.49*(0.27–0.91)
Live with others	1.36 (0.85–2.16)	1.34 (0.84–2.14)	1.28 (0.80–2.05)
Self-rated health	0.43***(0.65–1.19)	0.46***(0.39–0.54)	0.46***(0.39–0.54)
Have chronic disease	0.88 (0.65–1.19)	0.88 (0.65–1.18)	0.88 (0.65–1.18)
Pseudo R^2	0.169	0.178	0.182
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$			

Controlling for sociodemographic and health-related characteristics, PASE scores were negatively associated with depression. Older adults who had higher PASE scores were less likely to be depressive (*OR* = 0.99, 95% CI = 0.99–0.999). Patterns of PA also showed significant association with depression; compared with older adults who were domestic types, the athletic types were less likely to report depression (*OR* = 0.35, 95% CI = 0.17–0.71), while the gardening/caring types were more likely to report depression (*OR* = 1.55, 95% CI = 1.06–2.26). There were no significant differences in depression between the domestic types and the walkers.

The joint influence of levels and patterns of PA on depression

Figure 2 presents the multivariate-adjusted relative risk of depression according to levels of PA (PASE quartile: 0–25%, 25–50%, 50–75%, 75–100%) and patterns of PA (domestic types, athletic types, gardening/caring types, and walkers). Results were adjusted for age, gender, education, income, marital status, living arrangements, and physical health status. Older adults who were the most active (PASE quartile: 75–100%) and the athletic types had the strongest significant association with depression (relative risk = 0.21, 95% CI: 0.06–0.68), followed by those who were the most active (PASE quartile: 75–100%) and the walkers (relative risk = 0.28, 95% CI: 0.14–0.57) when compared with older adults with the least activity (PASE quartile: 0–25%) and domestic types. Older adults who were the most active (PASE quartile: 75–100%) and the gardening/caring types were most likely to be depressed (relative risk = 1.66, 95% CI: 1.03–2.69).

Discussion

Our study identified four latent classes of physical activity in community-dwelling older adults in Shanghai, China, including domestic types, athletic types, gardening/caring types, and walkers. Significantly, patterns of physical activity appeared to be associated with depression, because independent of the total amount of PA, athletic types seemed to have the greatest protective effect for depression. Gardening/caring types were associated with a higher risk for depression in subjects with the highest level of activity (PASE quartile: 75–100%). To our knowledge, this is the first study that used a latent class approach to identify types of PA and explore their influence on depression in Chinese community-dwelling older adults. Our results share several similarities with the findings of Mooney et al. and Joshi et al. [30, 17]. Mooney et al. [30] identified five latent classes of physical activity in New York City residents aged 65–75: least active, walkers, athletic types, domestic/gardening athletic types, and domestic/gardening types. Our findings also confirmed the results by Joshi et al. [17] that older adults who performed athletic activities were at lower risk for depression.

Our findings supported an overall protective effect of PA on depression among community-dwelling older adults. When examining the joint effects of the quantity of physical activity and patterns of physical activity on depression incidence, we found that significant differences tended to emerge when older people were the most active (PASE quartile: 75–100%), indicating the protective effects of athletic types and walkers, and the inverse effect of gardening/caring types. The findings inferred that a dose-response relationship might exist. Previous intervention research showed that a larger treatment dose of exercise might result in a greater improvement in depressive symptoms [36, 37]; while other studies identified the favorable effect of light-intensity PA on depression prevention, but the same effect of moderate-to-vigorous PA was not observed [38, 39]. Although we know little about the optimal amount of PA activity needed to reduce the risk of depression [40], our findings suggested that different patterns of PA might have different dose-response relationships with depression and that such differences were significant in the highest level of PA.

It is interesting to note that gardening/caring types tended to associate with a higher risk of depression, especially in older adults with the highest level of activities. These findings are in line with some previous studies [41, 42]. A cross-sectional survey study involving 58 countries showed that caregivers had a significantly higher likelihood of having depression [41]. Choi et al. [42] also showed that caregiving was associated with a higher risk of depression in older European adults. One study noted that caring may provide the opportunity to experience the benefits of caring [43]; however, studies also showed that increased hours spent caring was associated with depression, as increasing caring time may decrease time for doing more pleasurable activities [44, 45]. This may explain why an adverse effect of caring on depression was observed in the highest level of PA. Andrade-Gómez et al. [46] pointed out that walking or playing sports might be more effective in reducing the risk of depression than domestic work, such as rearing children or gardening. This further emphasized the importance of inquiring about the underlying mechanisms regarding different patterns of PA and depression.

From a physiological perspective, physical activities such as walking or playing sports may cause immune system changes by reducing some inflammatory markers [47]. It was also found that monoamines and endorphins increased after exercise [48, 49]. From psychological and social perspectives, PA may increase social interaction and enhance feelings of enjoyment, self-worth, and self-esteem [46]. In line with previous studies [50–52], our findings support the benefits of exercise (walking and athletic activity) on depression. Our study suggested that domestic activities cannot replace exercise for depression prevention and that we must pay more attention to the older adults who are highly engaged in gardening and caring activities. Gardening or caring may be routine, obligatory, or repetitive [45], and with an increased level of such type of activities, pleasurable feelings may become reduced and physical exhaustion may occur [53]. It seems that both psychosocial experience and levels of PA do matter for depression. Further research is warranted to explore how different patterns and quantity of PA influence depression physiologically and psychologically.

Strengths and limitations

One of the main strengths of this study was the use of LCA to identify patterns of PA among Chinese community-dwelling older adults, solving the problem that different types of PA may be too highly correlated to be compared directly. The results of LCA can be used to direct the development of individualized interventions for the Chinese community-dwelling older adults. Further, we used population-based data to examine the joint effects of levels and patterns of PA on depression, which expanded our understanding of the mechanisms underlying the associations among doses and types of PA and the likelihood of depression.

Several limitations should be noted. First, this study had a cross-sectional design, which precludes inference on causality. Second, data on PA were self-reported and thus could be prone to recall bias. Third, although we controlled for important confounders, there could still be bias due to unmeasured confounding variables. Fourth, our sample was from only one district of Shanghai, China; thus, further study is warranted to replicate our results.

Conclusion

In conclusion, we found that both the quantity and patterns of physical activity are associated with depression. Our work suggested an overall protective effect of physical activity on depression among community-dwelling older adults. Our findings suggested two important features to guide the development of interventions. First, population-level intervention should combine athletics with other patterns of physical activity among community-dwelling older adults. Second, to individually develop tailored interventions, more attention should be paid to older adults who are highly engaged in caring for others.

Declarations

Ethics approval and consent to participate

This research protocol was approved by the Ethical Review Board of Fudan University, and informed written consent was obtained before data collection. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

Our data may not be shared directly, because it is our teamwork; informed consent should be attained from all the team members. Our data or material may be available after contacting the corresponding authors.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YL, XL, YJ, YW participated in the design of the study, contributed to data collection, data analysis and interpretation of results; YY, YH participated in the design of the study; TY, ML, YR contributed to data collection and data analysis. All authors contributed to the manuscript writing. All authors have read and approved the final version of the manuscript, and agree with the order of authorship.

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Figures

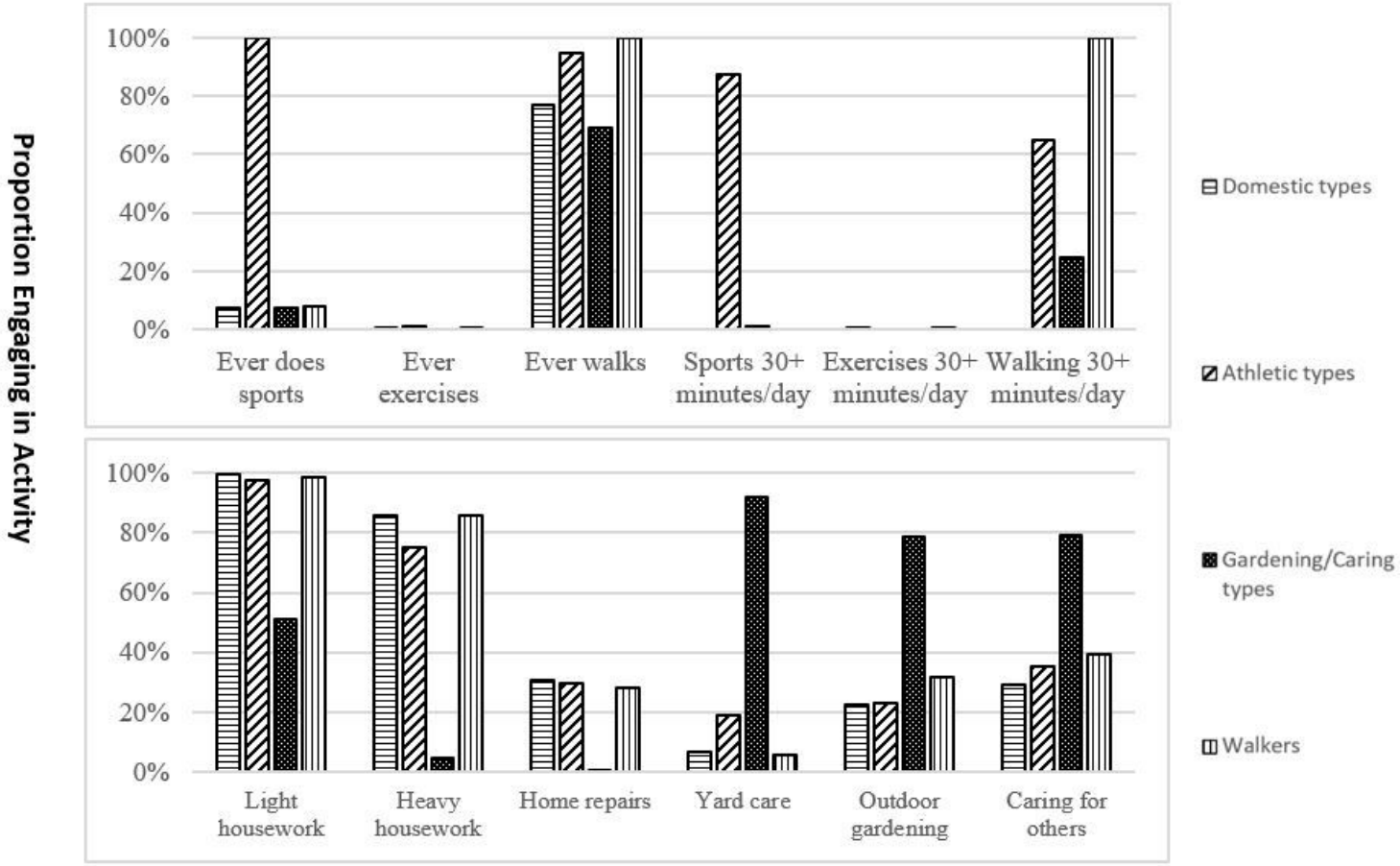

Figure 1

Proportion of activity reported by community-dwelling older adults in Shanghai, China, grouped by four latent classes.

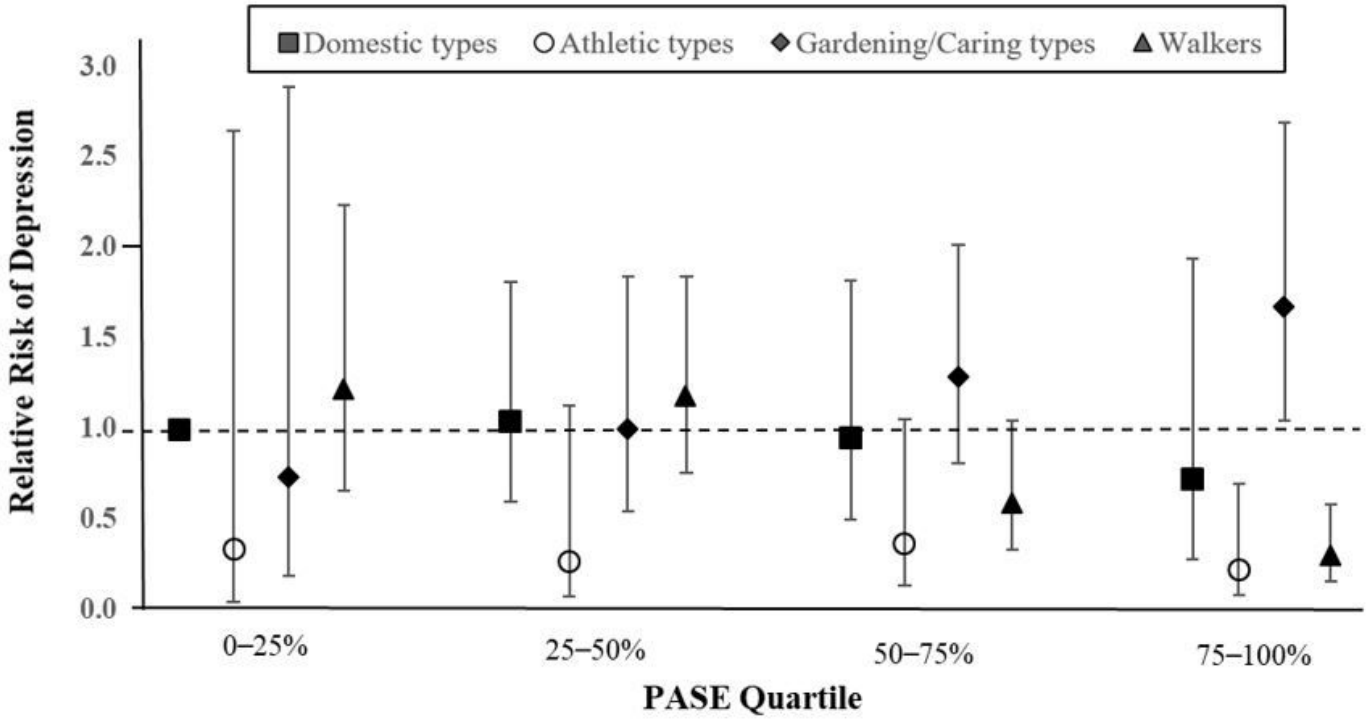

Figure 2

Multivariate-adjusted relative risk of depression according to levels of physical activity (PASE quartile: 0–25%, 25–50%, 50–75%, 75–100%) and patterns of physical activity (domestic types, athletic types, gardening/caring types, and walkers). Results were adjusted for the same covariates as in model 3 shown in Table 4. The reference group for relative risks was older adults with PASE quartile: 0–25% and domestic types. Bars show 95% confidence intervals.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1.Sociodemographicandphysicalhealthstatusquestionnaire.docx