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Philipe Barreto de Souto, Anne-Marie Ferrandez, Bérengère Saliba-Serre

Journal of Physical Activity and Health, 2013, 10, 359-367

JOURNAL OF
Physical Activity & Health
Official Journal of ISPAH
www.JPAH-Journal.com
ORIGINAL RESEARCH

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Background**:** Participation bias in exercise studies is poorly understood among older adults. This study was aimed at looking into whether older persons who volunteer to participate in an exercise study differ from nonvolunteers. ***Methods*****:** A self-reported questionnaire on physical activity and general health was mailed out to 1000 persons, aged 60 or over, who were covered by the medical insurance of the French National Education System. Among them, 535 answered it and sent it back. Two hundred and thirty-three persons (age 69.7 ±7.6, 65.7% women) said they would volunteer to participate in an exercise study and 270 (age 71.7 ±8.8, 62.2% women) did not. ***Results*****:** Volunteers were younger and more educated than nonvolunteers, but they did not differ in sex. They had less physical function decline and higher volumes of physical activity than nonvolunteers. Compared with volunteers, nonvolunteers had a worse self-reported health and suffered more frequently from chronic pain. Multiple logistic regressions showed that good self-reported health, absence of chronic pain, and lower levels of physical function decline were associated with volunteering to participate in an exercise study. ***Conclusions*****:** Volunteers were fitter and healthier than nonvolunteers. Therefore, caution must be taken when generalizing the results of exercise intervention studies.

Keywords**:** elderly, self-selection bias, exercise training, health behavior, ageing

Studies on exercise and functional fitness among older persons are often subject to biases in selecting the study population: volunteers are thought to be in better physical shape than their same-age peers in the general population. If this kind of bias is present in exercise studies, care must be taken in generalizing the results obtained. However, little information is available about this topic in the literature. As Rikli and Jones[1] indicated in a study about functional fitness among older adults, "presumably the types of individuals who volunteer to participate in research studies [ie, those who agree to be assessed (…)] differ from those who do not choose to participate." And according to these authors, volunteers are "willing" participants. However, these authors did not cite any research that has investigated this field.

Rodgers et al[2] studied an "exerciser stereotype" to see if exercisers are rated positively in several domains (eg, happy, fit, fat, lazy, strong, busy) as compared with nonexercisers who intend to exercise, and nonexercisers with no intention to exercise. They showed that exercisers were rated more favorably on 22 of the 24 domains studied, and concluded that, indeed, there is an "exerciser stereotype." Other researchers also obtained similar results regarding personality, physical functioning,[3] and appearance, including in older adults,[4] with exercisers being rated more favorably than nonexercisers or controls. However, these studies were based on participants' perceptions of exercisers and nonexercisers on various personality, physical functioning, and appearance dimensions, which do not inform us about the real differences between volunteer and nonvolunteer participants in an exercise study.

As far as we know, just 1 study, which investigated the participation bias in a program with exercise and psychological interventions among older adults, took into account information about people who refuse to participate in the study. In this study, van Heuvelen et al[5] compared individuals (age 57 or older) who participated in the trial (Participants) to 3 other groups: individuals who did not respond to the mail they received (Nonresponders), those who refused to participate (Refusers), and persons who agreed to participate but withdrew before the pretest (Withdrawers). Overall, when compared with the other groups, Participants had higher levels of education, physical activity, and physical functioning; they were also younger and suffered from fewer depressive symptoms. However, some questions remain unanswered: are volunteers who elect to participate in an exercise study fitter and healthier than those who do not elect to volunteer?

Although little information are available on this topic, some authors[6] showed that prior exercise behavior was a very important predictor of exercise adherence during a 6-month follow-up in an older population. It is

The authors are with Aix-Marseille Univ., CNRS UMR 7268 Anthropologie Bioculturelle, Droit, Ethique et Santé, France.

also plausible to imagine that physical function decline, chronic pain, and health status are important aspects for determining volunteering to participate in an exercise study. This because self-reported ability to execute several activities such as walking (a measure of physical function decline) is closely associated to[7] and constitutes an important predictor of physical activity[8] among the elderly. Chronic pain may also be able to determine the intention to participate in an exercise study because it is closely associated to physical function declines.[9,10] Moreover, chronic pain, a very frequent condition in older adults,[11] is a predictor of reduced mobility[12] in this population. According to a panel of experts,[13] another important aspect for determining older adults' initiation and adherence to exercise is health status. In this way, good self-reported health was already shown to be associated to changes on physical activity behavior.[14] Furthermore, although comorbidity seems to be less important than physical function for determining physical activity behavior,[15] it is strongly related to functional limitations and disability.[16] Therefore, the accumulation of chronic diseases may also be related to the intention to participate in an exercise study.

The aim of the current study was to determine whether older persons who volunteer (V) to participate in an exercise study are fitter and healthier than nonvolunteers (NV). We hypothesized that Vs would be fitter and healthier than NVs. In this way, volume of physical activity, physical function declines, chronic pain, self-reported heath, and the accumulation of chronic diseases should determine volunteering to participate in an exercise study.

Method

Participants

The original population for this study was composed of 8533 men and women, age 60 or over, living at home in Marseille in 2007, who were covered by the medical insurance of the French National Education System (a forerunning mutual health organization covering 3.3 million educational staff members and their dependants) from the Bouches-du-Rhône department of Southeastern France. From this population, 1000 individuals were selected using a stratified (on age and sex) random sampling method with proportional allocation. These individuals received a self-report questionnaire by mail that asked for information about health, physical activity, and sociodemographic characteristics (age, sex, and education). They were asked, "Some of the participants of this survey will be invited to participate in an exercise intervention study. Would you be interested in participating?" Five hundred and thirty-five older adults answered the questionnaire and sent it back. Their "age" and "sex" distributions were similar to those found in the selected sample of 1000 individuals, and therefore those of the original population composed of 8533 older individuals. Among the 535 older adults, 233 agreed to participate in the exercise study [called "volunteers" (V)], 270 did not [called "non-volunteers" (NV)], and 32 did not answer this question. Thus, the final sample of this study was composed of 503 respondents. They were mostly women (65.7% for Vs, and 62.2% for NVs), with a high level of education (87.4% of Vs had 12 or more years of formal education; 79% of NVs did so). The 32 persons who did not indicate whether they were interested in participating in an exercise study were excluded from the analyses.

The principles contained in the Declaration of Helsinki were followed for developing the current study. This study complies with ethical standards in France.

Measures

Physical Activity. Volume and level of physical activity were assessed by the *Questionnaire d'Activité Physique pour les Personnes Âgées* (Physical Activity Questionnaire for Older Adults, QAPPA). This questionnaire was elaborated and validated in French.[17] It asks for information about intensity (vigorous or moderate), frequency, and duration per day of physical activities carried out in the last 7 days. The amounts of time spent in vigorous and moderate activities were multiplied by a metabolic equivalent (MET), and the total volume of physical activity was calculated in MET-minutes/week, of vigorous activity (METV) and for moderate activity (METM). The total volume of physical activity (METT) was obtained by summing METV and METM. Based on volume and frequency, each participant's level of physical activity was rated as high, moderate, or low. From this, we created a dichotomous variable: "physically active" (high and moderate activity levels) versus "physically inactive" (low activity level).

Restrictions in Activities of Daily Living (ADL). This was assessed using an ADL scale with 6 activities of daily living (eg, getting out of bed, dressing, bathing) frequently used in the field of gerontology.[18] Individuals were asked if they are able to carry out these activities "alone, without difficulties" (score = 0), "alone, with some difficulties" (score = 1), "alone, with a lot of difficulties" (score = 2), or "with the help of someone else" (score = 3). Scores vary from 0–18 for this scale, with higher scores indicating higher levels of physical restrictions in executing ADLs.

Physical Function Decline. We used a scale[19] with 8 activities that evaluates individuals' ability to perform some daily physical tasks (eg, climbing 1 flight of stairs, lifting a packet of groceries of about 5kg, walking 500 m without stopping). Individuals were asked if they are able to carry out these activities "alone, without difficulties" (score = 0), "alone, with some difficulties" (score = 1), "alone, with a lot of difficulties" (score = 2), or "with the help of someone else" (score = 3). Scores vary from 0–24 for this scale, with higher scores indicating higher levels of physical function decline.

Chronic Diseases. Participants were asked to report if a physician had diagnosed one of the following chronic diseases or health problems: osteoarthritis, osteoporosis, bronchitis or pulmonary emphysema, diabetes, dyslipidemia, hypertension, coronary heart disease, stroke, Parkinson's disease, cancer, cataract, and others. If the option "others" was marked, participants indicated what chronic disease(s) or health problem(s) they had. From this, we created a variable called "number of chronic diseases."

Chronic Pain. Participants were asked if they suffered regularly from chronic neck, lower back, hip, or knee pain. This was a dichotomous variable (yes/no).

Self-Reported Health. This was rated as poor, fair, good, very good, or excellent. A dichotomous variable was created by grouping together "poor" and "fair" into "poor health" and "good," "very good," and "excellent" into "good health."

Body Satisfaction. This was assessed using 2 scales:[20] 1) satisfaction regarding physical functioning (eg, "strength") and 2) satisfaction regarding body appearance (eg, "weight"). Scores vary from 5–25 for physical-functioning satisfaction, and from 3–15 for body appearance satisfaction, with higher scores indicating higher levels of satisfaction.

Frailty Level. Based on current knowledge about frailty,[21,22] we used a scale[23] with 4 domains to operationalize frailty: 1) low muscle strength, 2) poor endurance, 3) Body Mass Index (BMI) < 18.5, and 4) low physical activity level. Muscle strength and poor endurance were assessed by 2 questions from the physical-functioning satisfaction scale. This frailty scale was adapted from the scale of Fried et al[21] to provide a valid measure of frailty based on self-report,[23] which would be easy to use and less time costly than existing measures of frailty. Those who answered "very dissatisfied" or "dissatisfied" to the following questions met the frailty criterion: "In the last 4 weeks how satisfied have you been with: your general muscle strength? and with your physical endurance?", respectively. Persons who met 3 or more frailty criteria were defined as "frail"; individuals who met 1 or 2 were defined as "pre-frail"; and subjects who met none of these 4 criteria were defined as "robust."

Other Variables. Participants also reported how many medications, prescribed by a physician, they took per day (categorical variable: ≤ 1; from 2–3; ≥ 4 medications), and their weight and height, from which BMI was calculated (weight, in kilograms, divided by squared height, in meters).

Statistical Analysis

We used the chi-square test to analyze differences between Vs and NVs on the categorical variables (sex, education, self-reported health, chronic pain, medications taken, frailty level, and physical activity level). We also checked to see whether Vs and NVs differed on each of the chronic diseases. Continuous variables were analyzed using Student' s *t* test for 2 independent samples (age and BMI) or the Wilcoxon Rank Sum Test when the data were not normally distributed (body satisfaction [physical functioning and appearance scales], number of chronic diseases, restrictions in ADL, physical function decline, and METV, METM and METT). Multiple logistic regression models adjusted for age, sex, and education were used to examine to what extent some of these variables were related to agreement to participate in an exercise study. Statistical analyses were performed using SPSS (version17.0) and SAS Software (version 9.1).

Results

The response rate at the current study was about 53% (from 1000 questionnaires mailed out, 535 were completed and sent back to researchers), which constitutes an acceptable rate for postal surveys among French populations. For example, Cormier et al[24] obtained a response rate of 18% in a sample composed of physicians that made hip surgery, whereas Jacqmarcq et al[25] found a response rate of 23% among anesthesiologists. A response rate of about 49% was obtained by Charmion et al[26] in a study among general practitioners, while Spieler and Pouvourville[27] obtained a response rate of 48% among stroke patients.

Comparisons between volunteers and nonvolunteers are shown in Tables 1 (for continuous variables) and 2 (for categorical variables). Vs were younger and more satisfied with their physical functioning than NVs. Moreover, Vs had lower physical function decline and higher volumes of physical activities (as assessed by METV, METM, and METT). There was no significant group difference in the number of chronic diseases, ADL score, satisfaction with body appearance, or BMI.

With regards to categorical variables, Vs had more education than NVs, but groups did not differ in sex. Vs had also a better self-reported health, took less medication, were less frequently defined as "pre-frail" or "frail," and suffered less frequently from chronic pain than NVs. Regarding the level of physical activity, Vs were not classified more often as physically "active" than were NVs (this difference remained a trend, $P = .07$). Furthermore, NVs and Vs did not differ on each of the chronic diseases studied, except for diabetes, which was less frequent among Vs ($P = .03$).

Each of the 6 logistic regression models (Tables 3 and 4) adjusted for age, sex, and education used to analyze the impact of some health variables on participation in an exercise study (dependent variable) indicated the relationship between one health-related or physical activity variable and the intention to participate in an exercise study. For each model, the Hosmer and Lemeshow goodness-of-fit statistic test indicated that the model fit the data quite well.

As Table 3 shows, general good self-reported health was related to an increased likelihood of participation in an exercise study. Suffering from chronic pain in the neck, lower back, hip, or knee was negatively associated to intention to enroll in an exercise study. Moreover, the higher the level of physical function decline, the

Table 1 Comparison Between Volunteers and Nonvolunteers for Continuous Variables

Variables	Vs (n = 233)		NVs (n = 270)		P
	Mean (SD)	Median [25th–75th]	Mean (SD)	Median [25th–75th]	
Age (years)	69.68 (7.58)	68 [63–74]	71.73 (8.83)	70 [64.25–78]	0.005[a]
BMI (kg/m^2)	24.67 (3.68)	24.41 [22.32–26.71]	24.67 (3.89)	24.38 [22.04–27.02]	0.993[a]
Appearance	10.03 (2.56)	10 [9–12]	9.75 (2.65)	10 [9–12]	0.327[b]
Functioning	17.86 (3.65)	18 [16–20]	16.27 (4.25)	17 [13–20]	< 0.001[b]
Physical function decline	1.98 (3.88)	0 [0–3]	3.62 (5.78)	1 [0–5]	0.018[b]
ADL	0.43 (1.85)	0 [0–0]	0.58 (2.02)	0 [0–0]	0.232[b]
Diseases	1.69 (1.18)	2 [1–2]	1.93 (1.45)	2 [1–3]	0.159[b]
METV	1499 (2254)	440 [0–2160]	1118 (2185)	0 [0–1440]	0.043[b]
METM	1226 (1202)	900 [360–1680]	1033 (1317)	600 [145–1310]	0.003[b]
METT	2741 (2624)	1760 [1080–3720]	2151 (2602)	1200 [520–3015]	0.001[b]

Abbreviations: BMI, body mass index; ADL, activities of daily living; METV, metabolic equivalent for the volume of vigorous physical activity; METM, metabolic equivalent for the volume of moderate physical activity; METT, metabolic equivalent for the total volume of physical activity.
[a] Student *t* test for 2 independent samples; [b] Wilcoxon Rank Sum test.

Table 2 Comparison Between Volunteers and Nonvolunteers for Categorical Variables (Chi Square Test)

Variables	Vs (n = 233; %)	NVs (n = 270; %)	P
Sex			
Male	34.3	37.8	0.42
Female	65.7	62.2	
Age			
60–69	57.1	48.6	0.04
70–79	30	30.7	
≥80	12.9	20.7	
Education			
>14 years	51.5	43.5	0.03
12–14 years	35.9	35.5	
<12 years	12.6	21	
Retirement (yes)	86.6	89.8	0.32
Chronic pain (yes)	49.6	62.1	0.005
Self-reported health (good)	73.8	59	0.001
Medications			
<2	34.2	25	0.03
2–3	37.2	37.1	
≥4	28.6	37.9	
Frailty level			
Robust	63.6	50.9	0.04
Prefrail	28.4	37.4	
Frail	8	11.7	
Physically active	79.4	71.3	0.07

lower the probability of intending to participate in such a study. The number of chronic diseases was not linked to the intention to enroll in an exercise study. Besides, when entered into the “chronic pain model” (Model 3), this variable did not modify the results obtained (data not shown). The other 2 models (Models 5 and 6), with substantially fewer individuals (Table 4), showed that physical-activity volume in the last 7 days, as well as frailty level, were not related to agreement to participate in an exercise study. When compared with robust older adults, the prefrail individuals tended to be less likely to participate in the exercise study (P = .07).

Table 3 Impact of Self-Reported Health (Model 1), Number of Chronic Diseases (Model 2), Chronic Pain (Model 3), and Physical Function Decline (Model 4) on the Probability of Being a Volunteer to Participate in an Exercise Study

	Model 1 (N = 456)			Model 2 (N = 487)			Model 3 (N = 491)			Model 4 (N = 467)		
Variables	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Age	0.975	[0.953–0.999]	0.039	0.981	[0.958–1.004]	0.10	0.976	[0.954–0.998]	0.035	0.982	[0.957–1.007]	0 .154
Gender: women	1.389	[0.922–2.094]	0.116	1.323	[0.882–1.982]	0.176	1.356	[0.908–2.025]	0.137	1.423	[0.944–2.145]	0.092
Education (ref.: low level)												
Intermediate level	1.308	[0.728–2.349]	0.369	1.521	[0.873–2.649]	0.139	1.668	[0.960–2.898]	0.070	1.310	[0.732–2.344]	0.364
High level	1.445	[0.809–2.581]	0.213	1.885	[1.093–3.252]	0.023	1.937	[1.126–3.334]	0.017	1.517	[0.859–2.681]	0.151
Health: good	1.806	[1.183–2.758]	0.006	–	–	–	–	–	–	–	–	–
Number of diseases	–	–	–	0.909	[0.782–1.056]	0.210	–	–	–	–	–	–
Chronic pain: yes	–	–	–	–	–	–	0.577	[0.397–0.838]	0.004	–	–	–
Physical function decline	–	–	–	–	–	–	–	–	–	0.939	[0.895–0.984]	0.009
Hosmer and Lemeshow goodness-of-fit test		0.957			0.676			0.218			0.611	

Table 4 Impact of Physical Activity Volume in the Last 7 Days (Model 5), and Frailty Level (Model 6) on the Probability of Being a Volunteer to Participate in an Exercise Study

	Model 5 (N = 364)[a]			Model 6 (N = 382)[a]		
Variables	OR	95% CI	*P*	OR	95% CI	*P*
Age	0.982	[0.955–1.011]	0.223	0.983	[0.956–1.010]	0.205
Gender: women	1.295	[0.816–2.057]	0.272	1.398	[0.882–2.215]	0.154
Education (ref.: low level)						
Intermediate level	1.350	[0.694–2.628]	0.376	1.313	[0.678–2.544]	0.42
High level	2.019	[1.062–3.838]	0.032	1.994	[1.055–3.766]	0.034
METT	1.000	[1.000–1.000]	0.117	–	–	–
Frailty level (ref.: robust)						
Prefrail	–	–	–	0.650	[0.409–1.033]	0.068
Frail	–	–	–	0.722	[0.332–1.572]	0.412
Hosmer and Lemeshow goodness-of-fit test		0.710			0.358	

Abbreviations: METT, Metabolic equivalent for the total volume of physical activity.

[a] Note that the reduction of the sample size is principally due to dropping individuals without calculable MET (Model 5) and frailty level (Model 6).

Discussion

This work showed that older adults who are inclined to enroll in an exercise study are at least partially fitter and healthier than ones who are not inclined to enroll. In our sample, Vs were more satisfied with their physical functioning, had a lower level of physical function decline, and higher volumes of vigorous, moderate, and total physical activity than NVs. They more often perceived their general health in a positive way, and took less medication than NVs. Furthermore, NVs suffered more often from chronic pain, and were more frequently defined as prefrail or frail than Vs. Although it is plausible to think that some of these results could be influenced by group differences in age and education, the logistic regression models, adjusted for age, sex, and education, showed that self-reported health, physical function decline, and chronic pain were related to the intention to participate in an exercise study, the first variable in a positive way, and the other 2 in a negative way.

Vs had better self-reported health than NVs, which corroborates the results obtained by Wagner et al.,[28] and differs from those obtained by Ives et al.[29] Wagner et al[28] showed for older adults that nonparticipants in a health promotion program had evaluated their health less favorably than participants. But Ives et al[29] indicated that older persons who refused to participate in a similar health promotion program were healthier than participants. Vs also exhibited better physical functioning (lesser score on physical function decline) than NVs, like participants in van Heuvelen et al's study[5] and in Elzen et al's study[30] on participation in a self-management intervention for chronically ill older persons. In the current study, self-reported health and physical function decline, after being controlled with sociodemographic variables, were associated with the intention to participate in an exercise study, suggesting that these variables play an important role in adopting a physically active lifestyle.

Vs also had higher volumes of physical activity than NVs. Thus, Vs were physically more active than NVs, which corroborates the results obtained by van Heuvelen et al.[5] The positive impact of a physically active behavior on functional limitation,[31] chronic pain,[32] and self-reported health[33] is well documented in the literature. Indeed, in our sample, Vs, who were physically more active than NVs, were also less functionally limited, had less chronic pain, and had better self-reported health. They were also more satisfied with their physical functioning. Furthermore, the fact that physical activity and exercise are important tools in chronic disease management[34] could explain our finding that Vs took fewer medications than NVs, even if they did not differ in the total number of chronic diseases and on each of the diseases taken separately (except for diabetes).

Regular pain in the neck, lower back, hip, or knee is frequently related to certain chronic diseases, especially osteo-articulatory chronic diseases such as osteoarthritis and osteoporosis. However, in our study these conditions did not differ significantly between Vs and NVs. Moreover, the number of chronic diseases was not significantly different between the 2 groups, which corroborates the van Heuvelen et al's[5] findings, but diverges from those obtained by Ives et al.;[29] Ives et al[29] showed that older participants in a health promotion program were more likely to have disease history and behavioral risk factors for disease than nonparticipants. The number of chronic diseases did not determine volunteering to participate in an exercise study, and did not change the influence of chronic pain in determining the intention to participate in an exercise study. This may have occurred because chronic diseases, when they are treated, do not necessarily represent an impediment to carrying out different kinds of activities, including physical exercise. Conversely, although exercise can be a useful instrument for treating chronic pain,[32] chronic pain was associated with a low likelihood of participating in an exercise study. It is possible to imagine that the historical and negative public perceptions of exercise, such as "exercise does more harm than good"[35], are still present and contribute to people's refusal to participate in an exercise study; this aspect may be more important in older adult populations and among subjects who suffer regularly from osteo-articulatory pain. Further research is needed to find out more about older adults' knowledge of the relationship between exercise and pain.

Although NVs were more often classified as prefrail and frail, frailty level was not associated with the intention to engage in an exercise study in the logistic regression. This may have occurred because, although frailty is a condition characterized by an abnormal decline in physiological reserves that renders subjects more vulnerable to stressors and reduces the capacity to recover homeostasis, it is a different entity from functional limitation and disability.[36] Moreover, frailty can be associated with subclinical outcomes.[37] It means that frail older adults are not necessarily unfit or in bad health, at least when evaluated by clinical signs, but they are more likely to develop some poor health conditions. The finding must be highlighted: when age, sex, and education were controlled, frail older adults intended to exercise to the same extent as robust individuals. Because a low level of physical activity is strongly related to frailty,[38,39] exercise programs could be a feasible way to improve health in this population. However, the feasibility and effectiveness of exercise in frail older populations is still not well-known,[40] and further research is needed on this topic.

This study confirms some of the results obtained by van Heuvelen et al,[5] and indicates that volunteers to engage in an exercise study are fitter and feel healthier than nonvolunteers, thus evidencing a participation bias in exercise studies. These findings should be taken into account when generalizing the results of controlled exercise trials. For example, a possible consequence related to this participation bias could be, on one hand, an underestimation of the effects of the exercise training because participants would tend to be fitter than nonvolunteers since the beginning of the intervention; therefore, they would be able to improve their fitness to a lesser extent than subjects in poorer fitness conditions such as persons who decline to participate. On the other hand, some evidence indicates that exercise can be ineffective to improve health outcomes, and can even be harmful for very vulnerable persons such as some frail older adults;[22,41] thus this participation bias could overestimate exercise effects among vulnerable older populations. However, further research is needed to confirm these possible consequences related to the participation bias in exercise studies.

To improve our current understanding on participation bias in exercise intervention studies, a qualitative study that investigates older adults' perceptions about the relationship between exercise and osteo-articulatory pain seems to be an important approach. Using objective measures of physical function can also provide more precise information about the impact of age-related declines in physical function on volunteering to participate in exercise interventions. A research that finds out the reasons indicated by dropouts for quitting an exercise intervention study would help to increase exercise adherence rates; knowing the reasons of participants for compliance and attendance in exercise trials also seems to be of great relevance.

The present work has some limitations: 1) we obtained a response rate of 53.5%; so, 46.5% of individuals contacted by mail did not complete the questionnaire, which may already constitute a participation bias; 2) the current study was based on a self-reported questionnaire, which may have reduced accuracy on some variables; and 3) the participants were covered by the medical insurance of the French National Education System, so they were probably better educated than their same-age peers in France and are not representative of the socioprofessional diversity found in this country.

Conclusions

In sum, this study revealed a participation bias related to volunteering for an exercise study. In our sample, Vs were fitter and felt healthier than NVs. Self-reported health, chronic pain, and physical function decline were important aspects associated to volunteering, with physical function decline probably being the most important variable in determining whether a person will volunteer or not. However, further research is needed to determine to what extent the participation bias found in exercise studies can affect the results obtained, and to find out how to make exercise programs more attractive for the more vulnerable older populations. Further research is also needed to find out about public perceptions and social constructions related to exercise among older people, and about how they conceive of the relationship of exercise to self-perceived health and chronic pain.

Acknowledgments

We thank Vivan Waltz for help with the English version.

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