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Eleven-year physical activity trends in a Swiss urban area

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ABSTRACT

Objective. Regular physical activity is a major health determinant. Little is known about physical activity trends. We evaluated whether adult physical activity levels are changing in a Swiss urban state (Geneva).

Method. We analyzed 11-year trends of physical activity indicators, including 3+ MET-minutes per week and physical activity outside working hours, in population representative adults (n = 9320, aged 35–74 years, 50% women), relating declared physical activity to socioeconomic status, lifestyle, and clinical and blood markers.

Results. Combining yearly cohorts from 1999 to 2009, we found a significant trend for increased physical activity levels. Weekly age and sex adjusted 3+ MET-minutes per week increased from 3023 to 3752, between 1999 and 2009 ($P = 0.02$). The increase also concerned physical activity outside working hours (+18 kcal/day/year). There was a shift from low levels of physical activity levels towards higher activities. Physical activity indicators were associated with socioeconomic status, comorbidities, and biological and anthropometric measures. The trend for increased physical activity was more prominent over the latter 5 years.

Conclusion. We found that physical activity levels have increased in an urban Swiss state. The increase is significant but small, and further efforts to promote physical activity are therefore warranted.

Introduction

Insufficient regular physical activity (PA) increases all-cause mortality risk (Archer and Blair, 2011; WHO, 2011). Over 60% of the world's population lacks sufficient PA (WHO, 2011). Increased transportation, labor saving technology at home and work, and less physically active recreational activities decrease PA (Knuth and Hallal, 2009). Continued monitoring of PA levels is important in order to document if PA levels change. International comparisons suggest differences in PA trends in the general adult population, with decreasing PA in some countries (e.g., USA (Brownson et al., 2005; Church et al., 2011), Spain (Meseguer et al., 2011)) and increasing PA in some others (e.g., Finland (Barengo et al., 2002; Borodulin et al., 2007), Canada (Craig et al., 2004), Australia (Chau et al., 2008)).

Since 1993 the '*Bus Santé*' study (Morabia et al., 1997) documents PA in yearly representative population samples of the State of Geneva (470,000 inhabitants in 2011). Using data from the '*Bus Santé*' study, Galobardes et al. reported that from 1993 to 2000 physical inactivity prevalence in Geneva state remained high and invariant (Galobardes et al., 2003). We hypothesized that PA levels continued to remain low and stable over the next ten years. We therefore determined trends in PA levels in Geneva using population representative data collected from 1999 to 2009 obtained with the same PA assessment method as used in the 1993–2000 analysis.

In addition, better understanding the causes of PA behavior is a prerequisite for interventions to increase PA. Correlates of PA (factors associated with PA) and determinants of PA (with a causal relationship) remain to be better defined (Bauman et al., 2012). Of particular interest is to determine the role of age, sex, education, health and socioeconomic status (Bauman et al., 2012). Thus, we examined the association of cardiovascular risk factors, biomarkers, and socioeconomic factors with PA.

Methods

Participants

The '*Bus Santé*' study is an on-going cross-sectional population-based study, which collects information on cardiovascular risk factors, diet and PA (Guessous et al., 2012). Briefly, every year a representative stratified sample of 500 men and 500 women from the population of the State of Geneva is recruited and studied in two fixed and one mobile medical unit. Trained collaborators interview and examine participants. All procedures are reviewed and standardized across technicians on a regular basis. Subjects are selected independently throughout each year to represent the Canton's approximately 100,000 male and 100,000 female non-institutionalized residents aged 35 to 74 years. Eligible subjects are identified using a standardized procedure using an annual residential list established by the local government.

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Each participant receives three self-administered, standardized questionnaires covering the risk factors for the major lifestyle dependent chronic diseases, socio-demographic characteristics, educational and occupational histories, and, for women, reproductive history. The 1999–2009 mean participation rate was 60% (range: 55%–65%). The Institutional Ethics Committee approved the study. All participants gave written informed consent.

Physical activity

PA was quantified by the same questionnaire throughout (PAFQ), developed for the Geneva population as reported in detail elsewhere (Bernstein et al., 1998). In short, a data-based approach was used; a 24-hour recall was administered to a random sample of 919 adult residents of Geneva, Switzerland. The data obtained were then used to establish a list of activities and their median duration that contributed to 95% of the energy expended. The PAFQ method was then validated in 41 volunteers against heart rate, prior to being calibrated with indirect calorimetry. The total energy estimated by the PAFQ correlated satisfactorily ($r = 0.76$) with estimates using heart rate (Bernstein et al., 1998). Respondents indicated days in the past week (0 to 7) and duration per day (0 to 10 h in 15 min increments) for each of 70 activities of which intensity is estimated with published multiples of METs (metabolic equivalent of task, 1 MET = 1 kcal/kg/h, approximating the energy expended during quiet sitting). Sex, age, weight and height specific resting metabolic rate (RMR) was estimated for each participant using the FAO/WHO/UNU equation (FAO/WHO/UNU. Energy and Protein Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Technical Report Series No. 724. Geneva: World Health Organization, 1985).

The PAFQ includes two sections: a professional activity section and a non-professional activity section. The participants fill out the sections accordingly. For example, participants without professional activities (e.g., retired, jobless) will fill out only the non-professional activity section. Subjects aged 65 years or more will fill out both sections if they still have professional activities. Trained collaborators verify the correct use of the questionnaire at the occasion of the visit for the measurements.

We derived: 1) total daily energy expenditure (kcal/day) (TEE): for all $PA_{(i)}$, the product of $MET_{(i)} \times duration_{(i)}$ in minutes per day × RMR in kcal was summed to RMR and thermic effect of food (10% TEE); 2) 3+ MET-minutes per week: for each $PA_{(i)}$ with MET ≥ 3, the product of $MET_{(i)} \times duration_{(i)}$ in minutes per week was computed and the sum across all such activities calculated; 3) daily EE related to physical activity only (kcal/day): TEE − RMR; 4) non-professional daily EE (NPEE, kcal/day): EE (kcal/day) restricted to leisure-time activities; 5) physical activity level (PAL): TEE / RMR; 6) weekly minutes spent in light (1.6–2.9 METs), moderate (3–5.9 METs), and vigorous (6–8.9 METs) activities; and weekly minutes of moderate to vigorous physical activity (MVPA), the sum of moderate and vigorous activities.

Measurements

Body weight, height, blood pressure, and waist and hip circumferences were measured using standard procedures (Guessous et al., 2012). Body mass index (BMI) was defined as weight / height^2 and waist-hip ratio (WHR) was calculated. Overweight and obesity were defined as BMI 25.0–29.9, and ≥30 kg/m^2, respectively. Fasting blood samples were collected and glucose, total plasma cholesterol, HDL plasma cholesterol and triglycerides were assayed by using commercially available enzymatic kits (Bayer Technicon Diagnostics, CV 1.4%, 1.2%, and 1.5%, for glucose, cholesterol and triglycerides, respectively).

Socioeconomic indicators

Self reported education, income, and occupation were classified as: 1) education: low (elementary school or apprenticeship); and high (maturity/baccalaureate or higher); 2) household monthly income (Francs, 1CHF ≈ 1US$ as of September 2013): <3000 CHF; 3000–4999 CHF; 5000–6999 CHF; 7000–9499 CHF; 9500–13,000 CHF; and >13,000 CHF; 3) occupation: non-manual, manager or independent; non-manual, employed; manual, independent; manual, employed; and man-at-home, retired, jobless, or disability insurance.

Medical history and comorbidities

Smoking status (never smokers, ex-smokers, current smokers), medical history and comorbidities (myocardial infarction, diabetes, hypertension, hypercholesterolemia) were self-reported. Subjects with fasting glucose >7 mmol/L, systolic blood pressure (SBP) ≥140 mm Hg, diastolic blood pressure (DBP) ≥90 mm Hg, or total cholesterol >6.5 mmol/L were considered having diabetes, hypertension or hypercholesterolemia.

Statistical analyses

Statistical analyses were performed using Stata 10.0 (Stata Corp, College Station, USA). Continuous variables were expressed as median ± confidence intervals (CI) or standard errors (SE). Median regressions were used to estimate adjusted PA and to assess associations of PA indicators with survey year, socioeconomic status, anthropometric and biologic measures. Below, we report the associations between determinants and the 3+ MET-minutes per week PA indicator. Mean regressions were used to estimate adjusted proportion in light, moderate and high PA, by survey year. PA indicators by sex were adjusted for age and PA indicators by age were adjusted for sex. All other analyses were adjusted for both sex and age. In addition, we considered the temporal changes in attributes that could potentially influence PA levels and ran additional models adjusting for those attributes when they presented significant changes. The linearity of association between PA indicators and survey year was tested using median regression. When linearity was not rejected ($P \geq .05$), linear trends were tested using linear regression. When linearity was rejected, median regression was used to test trends. Because fewer participants were included in years 2005, 2006, 2007 and 2008 we conducted additional analyses combining years 2005 to 2008. A P value <.05 defined statistically significant associations or trends. Interactions by survey year were additionally tested in analyses by socioeconomic status, anthropometric and biologic measures. A P value <.10 defined statistical interactions. This cutoff of for interaction tests was used because of the usual low power of epidemiologic studies for detecting interactions (Selvin, 1996).

Table 1
Participants' characteristics, Geneva Bus Santé study, 1999–2009.

	N	Mean or % (95%CI)
Age (mean)	9320	51.5 (51.3–51.7)
35–49 y ear(%)	4455	47.8 (46.8–48.8)
50–64 y ear(%)	3492	37.5 (36.5–38.5)
65+ year (%)	1373	14.7 (14.0–15.4)
Men (%)	4661	50.0 (49.0–51.0)
Never smoker (%)	4193	45.0 (43.9–45.9)
Ex-smoker (%)	2772	29.7 (28.8–30.7)
Current smoker (%)	2355	25.3 (24.4–26.1)
Body mass index (BMI) (mean)	9300	25.1 (25.0–25.2)
18.5–24.9 (%)	4795	52.6 (51.6-53.7)
25–29.9 (%)	3209	35.2 (34.2–36.2)
30––34.9 (%)	872	9.6 (8.9–10.1)
35–39.9 (%)	177	1.9 (1.6–2.2)
≥40 (%)	54	0.6 (0.4–0.7)
Hypertension (%)	3204	34.4 (33.4–35.3)
Diabetes (%)	570	6.3 (5.6–6.6)
Myocard infarction history (%)	179	1.9 (1.7–2.2)
Waist-to-hip ratio (mean)	2148	0.87 (0.86–0.88)
Total-cholesterol, mmol/L (mean)	2120	5.5 (5.4–5.6)
HDL-cholesterol, mmol/L (mean)	2120	1.4 (1.3–1.4)
Triglycerides, mmol/L (mean)	1809	1.3 (1.3–1.4)
Glucose, mmol/L (mean)	1809	5.1 (5.1–5.2)
Education level (%)		
Low (elementary school or apprenticeship)	4473	49.8 (48.7–50.8)
High (maturity or higher)	4513	50.2 (49.2–51.3)
Monthly household income (%)		
<3000 CHF	118	5.2 (4.3–6.2)
3000–4999 CHF	323	14.3 (12.9–15.8)
5000–6999 CHF	396	17.6 (16.0–19.5)
7000–9499 CHF	474	21 (19.3–22.7)
9500–13,000 CHF	409	18.1 (16.6–19.8)
>13,000 CHF	395	17.5 (15.9–19.1)
Job position (%)		
Non-manual, manager or independent	496	22.1 (20.3–23.7)
Non-manual, employed	555	24.6 (22.8–26.4)
Manual, independent	136	6 (5.1–7.0)
Manual, employed	367	16.3 (14.8–17.8)
Man-at-home	147	6.5 (5.5–7.5)
Retired, jobless, or disability insurance	550	24.4 (22.6–26.2)
Swiss citizenship (%)	4965	54.2 (53.2–55.2)