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Health impact of sport and exercise in emerging adult men: a prospective study

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ABSTRACT

Purpose

Health benefits of sport and exercise are well documented in children, adolescents and adults, but little is known about emerging adulthood—a period of life characterized by significant demographic and developmental changes. The present study aimed to assess the health impact of changes in sport and exercise levels during that specific period of life.

Methods

The analysis used baseline and 15-month follow-up data (N=4846) from the Cohort Study on Substance Use Risk Factors (C-SURF). Associations between baseline exercise levels or changes in exercise levels, and health indicators (i.e. health-related quality of life, depression, body mass index, alcohol dependence, nicotine dependence and cannabis use disorder) were measured using Chi-squared tests and ANOVA. Direction of effects was tested using cross-lagged analysis.

Results

At baseline, all health indicator scores were observed to be better for regular exercisers than for other exercise levels. At follow-up, participants who had maintained regular exercise over time had better scores than those who had remained irregular exercisers or had discontinued, but their scores for health related quality of life and depression were close to those of participants who had adopted regular exercise after the baseline questionnaire. Cross-lagged analysis indicated that regular exercise at baseline was a significant predictor of health related quality of life and substance use dependence at follow-up, but was itself predicted only by health related quality of life.

Conclusions

From a health promotion perspective, this study emphasizes how important it is for emerging adult men to maintain, or adopt, regular sport and exercise.

Keywords: Sports, physical activity, health, quality of life, prevention, young adult

INTRODUCTION

The promotion of an active lifestyle has become a priority for modern societies. An abundance of studies converges towards an inverse relationship between the amount of habitual physical activity and a variety of negative health outcomes throughout life [1,2]. Beyond disease prevention and treatment, regular physical activity is also beneficial to general well-being; a systematic review conducted on adult-based studies indicated a positive association between levels of physical activity and health-related quality of life [3]. Research on younger individuals is scarce, and has mainly focused on clinical sample populations such as cancer survivors [4]. A population-based study of 25-year-old Finnish men showed that higher levels of leisure time physical activity were positively associated with certain dimensions of health-related quality of life [5]. In children and adolescents, regular exercise also positively influences health outcomes [6-8]. To our knowledge, no study has investigated the relationship between exercise levels and health status in the period of life between adolescence and adulthood, and the present study was intended to fill this gap.

A few longitudinal studies were carried out on the question of whether physically active adolescents had a better health in adulthood than their inactive counterparts. A weak association was reported between youth physical activity and adult cardiovascular disease risk [9-12], and inconsistent results with regards to health related quality of life [13-15]. One possible explanation is that participating in regular physical activity is not as stable as commonly believed, particularly in transitional phases such as from adolescence to adulthood [16]. A recent Norwegian health survey [17], whose participants were 13–19 years old at inclusion, observed that only those who maintained regular exercise over time demonstrated significantly lower cardiovascular disease risk and better mental health ten years later.

The concept of emerging adulthood was developed by Arnett to characterize the period of life comprised between the ages 18 and 25 [18]. This is a phase of profound demographic changes, such as leaving home and becoming financially independent. Another important aspect during this period is further exploration of one’s identity, which leads to high rates of risky behavior. For instance, emerging adulthood is a developmental period characterized by peak prevalence of substance use problems [19]. Given the import role of physical activity in disease prevention and health promotion in adults and adolescents, emerging adults are also likely to benefit from sport and exercise in terms of improved quality of life and decreased prevalence of substance use dependence.

The present study’s aims were to assess the associations between health indicators and both sport and exercise levels and changes in sport and exercise levels over time. Furthermore, it aimed to determine whether a predominant direction of effects existed; that is, whether a change in sport and exercise level is the cause or the result of a change in health indicators.

METHODS

Study design

Data from the Cohort Study on Substance Use Risk Factors (C-SURF) were analyzed. Participants were enrolled from 3 of 6 national military recruitment centers, covering 21 of 26 Swiss cantons (including all French-speaking ones). Since attending military recruitment is mandatory in Switzerland, without any pre-selection, it provides a representative sample of young Swiss men. Recruitment centers were used to enroll participants, but assessments at baseline and follow-up were done outside the military environment. Questionnaires were sent to the participants' private addresses, to be completed at home and returned using a pre-paid, addressed envelope. Participants were informed that data would be kept strictly confidential and would not be shared with third parties, including the army. With the participants' responses hidden from the army they had no reason to conceal answers which might have influenced the recruitment process. Baseline data were collected between September 2010 and March 2012, and follow-up data between January 2012 and April 2013.

Participants

A total of 13245 conscripts were informed about the study, of whom 7563 gave written consent and 5990 completed the questionnaire at baseline. Of these, 5223 (87.2%) completed the follow-up questionnaire. Missing values were deleted listwise, and the analyses were based on a final sample of 4846 participants (92.8% of follow-up responders). Detailed analyses indicated only small differences between consenters and non-consenters [20], and between responders and non-responders [21]. In brief, although the use of alcohol, tobacco and cannabis was higher in non-responders and non-consenters compared to responders and consenters respectively, effects were small and partly inconsistent (e.g. more alcohol abstainers among non-responders and non-consenters). Ethical approval for the study was granted by Lausanne University Medical School's Clinical Research Ethics Committee (Protocol No. 15/07).

Measurements

Sport and exercise

A single question was used to measure sport and exercise: ‘Over the past 12 months, how often did you participate in sports or exercising?’ Response choices were: ‘never’ (1); ’a few times a year’ (2); ‘1 to 3 times per month’ (3); ‘at least once per week’ (4); or ‘almost every day’ (5). Regular exercise was defined as participating in sports or exercising almost every day. Changes in sport and exercise over time were defined on the basis of being a regular exerciser or not, at baseline and at follow-up. The following groups were used: a) ‘resisters’ (not regular exercisers at either baseline or follow-up); b) ‘lapsers’ (regular exercisers at baseline, but not at follow-up); c) ‘adopters’ (regular exercisers at follow-up, but not at baseline); and d) ‘maintainers’ (regular exercisers at baseline and at follow-up).

Health-related quality of life

The Medical Outcomes Study 12-item Short Form Health Survey (SF-12v2) was used to measure health-related quality of life [22]. The ‘physical health’ and ‘mental health’ summary scores were computed. Norm-based scores were obtained using linear transformations (mean=50; SD=10).

Depression

The Major Depressive Inventory (MDI) was used to assess states of depression [23,24]. The MDI contains 10 items answered on a 6-point Likert scale, from ‘never’ (0) to ‘all the time’ (5). A study of the psychometric properties of the MDI indicated adequate internal validity (Rasch analysis, Mokken analysis) and external validity (high correlation with the Hamilton Depression Scale) [24]. The MDI was used as a measuring instrument rather than as a diagnostic one. Hence, a continuous score (ranging from 0 to 50) was used instead of a cut-off to better capture variability across the range of symptoms for depression.

Body mass index

Self-reported data on height and weight were used to calculate body mass index (BMI, kg/m^2). Participants were categorized as underweight (BMI <18.5), normal weight (BMI 18.5 to <25), overweight (BMI 25 to <30), and obese (BMI ≥30) [25].

Alcohol dependence

Alcohol dependence status was determined according to the methodology described by Knight et al. [26]. Self-reporting of the dependence criteria in the Diagnostic and Statistical Manual, fourth edition (DSM-IV), were used. An alcohol dependence status was defined as a positive response to any 3 or more of 7 dependence criteria [26].

Nicotine dependence

Nicotine dependence levels were assessed using the Fagerström Test for Nicotine Dependence [27], a 6-item questionnaire yielding a score ranging between 'no symptom of dependence' (0) and 'high number of symptoms of dependence' (10). A nicotine dependence status was defined as a score of 4 or above [28].

Cannabis use disorder

Cannabis use disorder was assessed using the Cannabis Use Disorder Identification Test (CUDIT), a screening instrument providing a score between 'no symptom of dependence' (0) and 'high number of symptoms of dependence' (40). Cannabis use disorder was defined as a score of 8 or above [29].

Socio-demographics

At baseline, socio-demographic variables were measured and recorded as follows: *age*, *language* ('German'; 'French'), *highest educational level achieved* ('lower secondary school'; 'vocational upper secondary school'; 'general upper secondary school' [high school or equivalent]; 'tertiary' [university or other graduate school]), *employment status* ('employed'; 'student'; 'inactive' [unemployed, social or disability pension]), *type of community* ('rural' [below 10000 inhabitants]; 'urban' [10000 inhabitants or above]). The assessment of educational level in young adults is hindered by the fact that a large number of them had not yet reached their highest educational level. Therefore, *parents' educational level* ('lower secondary school'; 'vocational upper secondary school'; 'general upper secondary school' [high school or equivalent]; 'tertiary' [university or other graduate school]) and *perceived family financial situation* ('below average'; 'average'; 'above average') were also measured. *Army status* at follow-up ('military service'; 'civilian service'; 'no service') may be associated with exercising and was therefore added as a control variable.

Statistical analysis

Descriptive statistics were used to present demographic characteristics and health indicators according to sport and exercise and changes in sport and exercise. Differences between levels of sport and exercise at baseline, or changes in sport and exercise between baseline and follow-up, were tested using one-way ANOVA (continuous variables) or Chi-squared tests (categorical variables). In cases of significant ANOVA or Chi-squared results, post-hoc analyses were computed using Tukey HSD tests or standardized residuals (difference between observed and expected frequencies), respectively. P-values of pairwise comparisons were corrected to adjust for multiple post-hoc comparisons with an overall $p<.05$ used as the significance level.

One of the present study's aims was to resolve the important issue of whether health predicts sport and exercise, sport and exercise predicts health, or both causal relationships are true. To test reciprocal causality, cross-lagged path analysis was applied. This type of structural equation model involves computing 3 kinds of correlations between variables measured at two time points (t_1 and t_2) [30]. Synchronous correlations refer to the cross-sectional association between different variables at each time point; autocorrelations refer to the association of a variable at t_2 with its level at t_1; and cross-lagged correlations refer to the association of a variable at t_2 with other variables at t_1. Therefore, the cross-lagged correlations give the impact of one variable in the past on the future values of another variable, and this over and above the association that these variables have at the same point in time. A model was computed to include: synchronous correlations of regular exercise with all health outcomes at t_1 and t_2; autocorrelations of all variables; cross-lagged correlations of all health outcomes at t_2 with regular exercise at t_1 (to determine if regular exercise predicts health); and cross-lagged correlations of regular exercise at t_2 with all health outcomes at t_1 (to determine if health predicts regular exercise). The model was controlled for all socio-demographic variables at baseline, and for army status at follow-up (military service, civilian service, no service). Model fit was assessed using the root mean square error of approximation (RMSEA), that should not be over .06, and the comparative fit index (CFI), that should not be under .95 [31]. The analyses were conducted using SPSS 21 software (IBM, Armonk, NY), except for the cross-lagged path analysis which was computed using Mplus 6 software [32].

RESULTS

Demographic characteristics

Table 1 displays the demographic characteristics for the whole sample, and stratified by sport and exercise levels at baseline. Each variable differed significantly between levels of sport and exercise.

Post-hoc analyses showed that participants who indicated low levels of sport and exercise where likely to be older than those who indicated a high level. Never exercisers were associated with speaking French (p<.002), a below average perceived family financial situation (p<.001), an education to vocational upper secondary school level (p=.017), and being employed (p=.007) or inactive (p=.035). Regular exercisers were associated with an above average perceived family financial situation (p=.043) and were negatively associated with being inactive (p=.031).

Health according to sport and exercise levels at baseline

As indicated in Table 2, all the health indicators showed significantly different results according to sport and exercise levels at baseline. Post-hoc analyses showed that physical health, mental health and depression scores were significantly higher in regular exercisers than in all other levels of sport and exercise (all p<.001). With regard to BMI, never exercisers were associated with a high prevalence of being obese (p=.004). Regular exercisers were associated with a low prevalence of being underweight (p<.001), overweight (p=.011) or obese (p=.009), and a high prevalence of being of normal weight (p=.007). Regarding substance use, never exercisers were associated with high rates of alcohol dependence, nicotine dependence and cannabis use disorder (all p<.001). Regular exercisers were associated with low rates of nicotine dependence (p<.001) and cannabis use disorder (p<.001). These results suggest a dose-response relationsip between health status and sport and exercise levels.

Health at follow-up according to changes in sport and exercise levels

As indicated in Table 3, health indicators at follow-up differed significantly according to participants changes in sport and exercise levels (resisters, lapsers, adopters, maintainers), except for alcohol dependence; in this case, a lower prevalence (6.4%) was observed in maintainers than in other categories, but this difference did not reach significance (p=.218). Post-hoc analyses showed that maintainers scored significantly higher on physical health than both resisters (p<.001) and lapsers (p<.001), and that adopters scored significantly higher than resisters (p=.001). Mental health scores were significantly higher for maintainers than for resisters (p<.001) and lapsers (p=.003), and significantly higher for adopters than for resisters (p=.012). Depression scores were significantly lower for maintainers than for resisters (p<.001) and lapsers (p=.005). Effect sizes were small, with differences between resisters and maintainers in physical health, mental health and depression 0.26 standard deviations (SD), 0.28 SD and 0.24 SD, respectively.

With regards to BMI, resisters were associated with a high prevalence of being underweight (p=.002) or obese (p=.031).Maintainers were associated with a low prevalence of being underweight (p=.001) or obese (p=.028). Regarding substance use, resisters were associated with high rates of nicotine dependence (p<.001), whereas maintainers were associated with low rates of nicotine dependence (p<.001) and cannabis use disorder (p=.001).

Cross-lagged analysis on the direction of effects

The cross-lagged analysis examining the association between regular exercise and health indicators is depicted in Figure 1. Synchronous correlations are not presented, and for clarity only the significant autocorrelations and cross-lagged correlations are shown. The model exhibited an adequate fit to the data (RMSEA=.059, CFI=.94). Autocorrelations were significant for all variables and indicated moderate stability over time (range .307 to .656). Regular exercise at baseline significantly predicted physical health (β=.043, p=.002), mental health (β=.036, p=.007), alcohol dependence (β=-.073, p=.004), nicotine dependence (β=-.127, p<.001) and cannabis use disorder (β=-.100, p<.001), but not depression (β=-.012, p=.374) and normal weight (β=.027, p=.090) at follow-up. Regular exercise at follow-up, in turn, was significantly predicted by both physical health (β=.084, p<.001) and mental health (β=.126, p<.001).

DISCUSSION

The present study aimed to compare health indicators between different levels of sport and exercise in emerging adult men, and to determine if a change in sport and exercise levels affects health status. The results indicate a monotonic improvement of most health indicators with increasing exercise levels, indicating a dose-response relationship. Participants who maintained regular exercise from baseline to follow-up had better scores for health related quality of life and depression, and were less likely to be underweight, obese, or substance-dependent than those who exercised irregularly over time (resisters) and those who discontinued over time (lapsers). Interestingly, those who became regular exercisers over time (adopters) had physical health, mental health and depression scores close to those of maintainers. These results point to the importance for people who are regularly active to maintain their levels of sport and exercise, but also for insufficiently active people to adopt a regular level of sport and exercise.

All the demographic characteristics were significantly different according to the levels of sport and exercise at baseline. This complemented recent studies conducted on the determinants of physical activity in adolescents [33,34] or young people [35]. Cross-sectional associations showed that regular exercise was associated with high scores in health-related quality of life, a high prevalence of normal weight and low rates of nicotine dependence and cannabis use disorder. Numerous previous studies have indicated that participation in sport and exercise is related to lower levels of cigarette smoking and illegal drug use, but higher levels of alcohol consumption [36]. However, in the present study, the highest rate of alcohol dependence was observed among those with the lowest frequency of exercise participation. Those who participated in sports and exercise at a high frequency did not exhibit higher rates of alcohol dependence (Table 2). This is in line with a recent study where different factors were associated with different stages of alcohol use [37]. It is also worth noting that outcomes were better in participants reporting 'at least once per week', and somewhat better in those reporting '1 to 3 times per month' than in those reporting 'a few times a year' and 'never'. This highlights not only the fact that participation in sport and exercise have to be regular in order to reap their significant health benefits, but it also extends the concept that some activity is better than none to emerging adult men [1].

Health indicators and sport and exercise levels were analyzed using a cross-lagged model to provide an indication of the direction of effects over time. Despite autocorrelations being significant for regular exercise and all health indicators, and even when baseline levels were controlled for, cross-lagged correlations indicated that doing regular exercise at baseline was predictive of a low prevalence of alcohol dependence, nicotine dependence and cannabis use disorder at follow-up. Baseline levels of these health indicators were, in turn, not significant predictors of regular exercise at follow-up. This suggests that the differences observed in alcohol dependence, nicotine dependence and cannabis use disorder, due to different sport and exercise levels (Table 2) or types of changes in sport and exercise levels over time (Table 3), are predominantly because of sport and exercise influencing health rather than the opposite. The absence of a significant association with depression at follow-up may be due to the relatively low levels of depression observed in this population. As regards quality of life, regular exercise at baseline was positively associated with physical and mental health at follow-up, but regular exercise at follow-up was in turn positively associated with physical and mental health at baseline. These results imply that sport and exercise is a valuable way of improving health-related quality of life, which is in turn a significant determinant of regular exercise. In the opposite direction, poor health-related quality of life appears to be a barrier to regular exercise, and not being a regular exerciser appears to be a predictor of poor health-related quality of life, thereby constituting a vicious circle perpetuating poor health-related quality of life. Although statistically significant, the magnitude of these associations is small, suggesting that other factors are involved.

The validity of subjective rather than objective measures is often questioned, particularly in sensitive topics such as substance use. In the present study, the procedures guaranteeing anonymity, the mode of administration (self-administered rather than interviewer-administered) and the relatively low stigmatization around the use of alcohol, cigarette and cannabis in Switzerland, do not support the idea that self-reporting equates to low validity. Some limitations must however be considered. First, the cross-lagged analysis used provides an indication of temporal precedence, but cannot be considered as an absolute proof of causation [30]. The observational nature of this study also precludes definitive causal inference, but addressing this research question using an experimental design appears very challenging and may actually be impracticable. Second, sport and exercise was assessed using a single-item question. Studies on adult populations have indicated that other components of physical activity (e.g. occupation or travel) are differently related to health status [38,39]. Future studies may be accompanied by clinical diagnosis of mental health and an objective measurement of sport and exercise. Third, health status was assessed based on a set of indicators relevant to that age group, but others (e.g. cardiovascular disease risk factors, hospital admissions or morbidity) were not covered. Moreover, small effect sizes limit the public health significance of the results. Finally, the present findings were obtained from a sample of emerging adult men, and must therefore be interpreted with caution with regard to women.

To the best of our knowledge, this study is the first investigation of the associations between sport and exercise levels and health in emerging adulthood. The results support the positive role of sport and exercise in preventing substance use dependence, depression and abnormal weight, and in promoting quality of life during that particular period of life. The importance of inactive individuals adopting regular exercise must be underlined, as should avoiding relapses, or discontinuing sport and exercise, among active ones.

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TABLES

Table 1. Socio-demographics for the total sample and for each level of sport and exercise at baseline

Characteristics *	Total (N=4846)	Never (N=244)	A few times a year (N=418)	1 to 3 times per month (N=665)	At least once per week (N=2034)	Almost every day (N=1485)	P †
Age [mean (SD)]	19.95 (1.19)	20.21 (1.26) [ab]	20.37 (1.32) [b]	20.02 (1.15) [ac]	19.91 (1.21) [cd]	19.82 (1.09) [d]	<.001
Language							
German	2238 (46.2%)	74 (30.3%) -	155 (37.1%) -	303 (45.6%)	977 (48.0%)	729 (49.1%)	<.001
French	2608 (53.8%)	170 (69.7%) +	263 (62.9%) +	362 (54.4%)	1057 (52.0%)	756 (50.9%)	
Perceived family financial situation							
Below average	680 (14.0%)	60 (24.6%) +	71 (17.0%)	109 (16.4%)	272 (13.4%)	168 (11.3%) -	<.001
Average	1977 (40.8%)	101 (41.4%)	210 (50.2%) +	267 (40.2%)	828 (40.7%)	571 (38.5%)	
Above average	2189 (45.2%)	83 (34.0%) -	137 (32.8%) -	289 (43.5%)	934 (45.9%)	746 (50.2%) +	
Highest education achieved							
Lower sec. school	2383 (49.2%)	121 (49.6%)	187 (44.7%)	308 (46.3%)	1038 (51.0%)	729 (49.1%)	.004
Vocat. upper sec. school	1149 (23.7%)	76 (31.1%) +	121 (28.9%)	172 (25.9%)	441 (21.7%)	339 (22.8%)	
Gen. upper sec. school	1224 (25.3%)	42 (17.2%) -	106 (25.4%)	171 (25.7%)	517 (25.4%)	388 (26.1%)	
Tertiary	90 (1.9%)	5 (2.0%)	4 (1.0%)	14 (2.1%)	38 (1.9%)	29 (2.0%)	
Parents' educational level							
Lower sec. school	276 (5.7%)	22 (9.0%)	33 (7.9%)	38 (5.7%)	102 (5.0%)	81 (5.5%)	.001
Vocat. upper sec. school	1698 (35.0%)	100 (41.0%)	161 (38.5%)	255 (38.3%)	705 (34.7%)	477 (32.1%)	
Gen. upper sec. school	819 (16.9%)	42 (17.2%)	68 (16.3%)	111 (16.7%)	334 (16.4%)	264 (17.8%)	
Tertiary	2053 (42.4%)	80 (32.8%)	156 (37.3%)	261 (39.2%)	893 (43.9%)	663 (44.6%)	

Table 1. (continued)

Characteristics *	Total (N=4846)	Never (N=244)	A few times a year (N=418)	1 to 3 times per month (N=665)	At least once per week (N=2034)	Almost every day (N=1485)	P †
Employment status							
Employed	2308 (47.6%)	149 (61.1%) +	242 (57.9%) +	353 (53.1%)	890 (43.8%) -	674 (45.4%)	<.001
Student	2282 (47.1%)	73 (29.9%) -	144 (34.4%) -	266 (40.0%) -	1046 (51.4%) +	755 (50.8%)	
Inactive	256 (5.3%)	22 (9%) +	32 (7.7%)	46 (6.9%)	98 (4.8%)	56 (3.8%) -	
Type of community							
Rural	2948 (60.8%)	136 (55.7%)	228 (54.5%)	420 (63.2%)	1292 (63.5%)	872 (58.7%)	<.001
Urban	1898 (39.2%)	108 (44.3%)	190 (45.5%)	245 (36.8%)	742 (36.5%)	613 (41.3%)	

SD = standard deviation

* Data are N (%), unless otherwise indicated

† ANOVA (age) or Pearson Chi-squared test (all other variables)

a, b, c, d Means with different subscript letters differ significantly (post-hoc Tukey HSD tests at p<.05)

+ Significantly higher prevalence than expected (standardized residuals >2.39 to adjust for multiple testing)

- Significantly lower prevalence than expected (standardized residuals <-2.39 to adjust for multiple testing)

Table 2. Health indicators according to sport and exercise level at baseline

Health indicators	Never (N=244)	A few times a year (N=418)	1 to 3 times per month (N=665)	At least once per week (N=2034)	Almost every day (N=1485)	ANOVA	
	Mean (95% CI)	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**	**Mean (95% CI)**	$F_{4, 4845}$	**P**
Physical health	52.59 (51.66-53.52) [a]	53.32 (52.75-53.90) [ab]	53.80 (53.37-54.22) [b]	55.23 (55.02-55.44) [c]	56.01 (55.78-56.25) [d]	49.81	<.001
Mental health	46.42 (45.03-47.81) [a]	47.71 (46.77-48.66) [ab]	48.52 (47.85-49.19) [bc]	49.38 (49.02-49.74) [c]	51.05 (50.64-51.45) [d]	26.96	<.001
Depression	10.69 (9.38-11.99) [a]	9.13 (8.28-9.97) [a]	7.65 (7.10-8.19) [b]	6.84 (6.55-7.12) [b]	5.81 (5.51-6.12) [c]	39.31	<.001
						Chi-squared	
	N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	χ^2	**P**
Body Mass Index							
Underweight	12 (4.9%)	32 (7.7%) [+]	37 (5.6%) [+]	67 (3.3%)	16 (1.1%) [-]	132.69	<.001
Normal weight	169 (69.3%)	277 (66.3%)	470 (70.7%)	1550 (76.2%)	1237 (83.3%) [+]		
Overweight	43 (17.6%)	75 (17.9%)	120 (18.0%)	350 (17.2%)	195 (13.1%) [-]		
Obese	20 (8.2%) [+]	34 (8.1%) [+]	38 (5.7%)	67 (3.3%)	37 (2.5%) [-]		
Alcohol dependence	45 (18.4%) [+]	42 (10.0%)	64 (9.6%)	207 (10.2%)	132 (8.9%)	21.26	<.001
Nicotine dependence	63 (25.8%) [+]	73 (17.5%) [+]	78 (11.7%)	150 (7.4%) [-]	72 (4.8%) [-]	164.76	<.001
Cannabis use disorder	51 (20.9%) [+]	55 (13.2%) [+]	76 (11.4%) [+]	156 (7.7%)	83 (5.6%) [-]	83.34	<.001

[a, b, c, d] Means with different subscript letters differ significantly (post-hoc Tukey HSD tests at p<.05) . For example, there is no significant difference, as regards physical health, between ‘never’ and ‘a few times a year’ (same subscript a), and between ‘a few times a year’ and ‘1 to 3 times per month’ (same subscript b). However, ‘1 to 3 times per month’ differs significantly from ‘never’, and ‘at least once per week’ and ‘almost every day’ each differ significantly from all other levels.

[+] Significantly higher prevalence than expected (standardized residuals >2.39 to adjust for multiple testing)

[-] Significantly lower prevalence than expected (standardized residuals <-2.39 to adjust for multiple testing)

Table 3. Health status at follow-up according to changes in sport and exercise levels

Health indicators	Resisters (N=2927)	Lapsers (N=562)	Adopters (N=434)	Maintainers (N=923)		
	Changes in sport and exercise levels					
					ANOVA	
	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	$F_{4, 5075}$	P
Physical health	54.97 (54.77-55.17) [a]	55.16 (54.67-55.66) [ab]	56.02 (55.49-56.55) [bc]	56.34 (56.02-56.67) [c]	17.32	<.001
Mental health	46.89 (46.55-47.22) [a]	47.68 (46.92-48.43) [ab]	48.31 (47.46-49.17) [bc]	49.37 (48.83-49.91) [c]	18.71	<.001
Depression	8.25 (7.99-8.52) [a]	7.92 (7.30-8.54) [a]	7.38 (6.72-8.03) [ab]	6.65 (6.27-7.03) [b]	12.48	<.001
					Chi-squared test	
	N (%)	N (%)	N (%)	N (%)	χ^2	P
Body mass index						
Underweight	110 (3.8%) [+]	6 (1.1%)	8 (1.8%)	6 (0.7%) [-]	69.16	<.001
Normal weight	2128 (72.7%)	445 (79.2%)	352 (81.1%)	751 (81.4%)		
Overweight	545 (18.6%)	94 (16.7%)	65 (15%)	147 (15.9%)		
Obese	144 (4.9%) [+]	17 (3%)	9 (2.1%)	19 (2.1%) [-]		
Alcohol dependence	249 (8.5%)	48 (8.5%)	36 (8.3%)	59 (6.4%)	4.44	.218
Nicotine dependence	353 (12.1%) [+]	41 (7.3%)	27 (6.2%)	43 (4.7%) [-]	55.66	<.001
Cannabis use disorder	279 (9.5%)	39 (6.9%)	35 (8.1%)	42 (4.6%) [-]	24.55	<.001

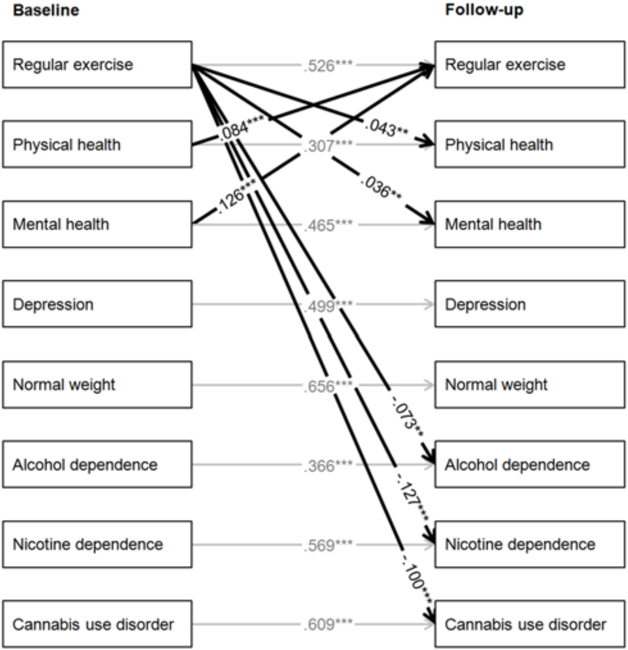
[a, b, c] Means with different subscript letters differ significantly (post-hoc Tukey HSD tests at p<.05). For example, there is no significant difference, as regards physical health, between resisters and lapsers (same subscript a), between lapsers and adopters (same subscript b) and between adopters and maintainers (same subscript c). However, adopters differ significantly from resisters and maintainers differ significantly from resisters and lapsers.

[+] Significantly higher prevalence than expected (standardized residuals >2.64 to adjust for multiple testing)

[-] Significantly lower prevalence than expected (standardized residuals <-2.64 to adjust for multiple testing)

FIGURE CAPTION

Fig. 1 Cross-lagged model analyzing the longitudinal association between regular exercise and health indicators. Synchronous correlations are not presented, and for clarity, only significant autocorrelations and cross-lagged correlations are presented. The model was controlled for all socio-demographic variables. ** $p<.01$; *** $p<.001$


Baseline
Follow-up
Regular exercise
Physical health
Mental health
Depression
Normal weight
Alcohol dependence
Nicotine dependence
Cannabis use disorder
Regular exercise
Physical health
Mental health
Depression
Normal weight
Alcohol dependence
Nicotine dependence
Cannabis use disorder
.526***
.307***
.465***
.499***
.656***
.366***
.569***
.609***
.084***
.126***
.043**
.036**
-.073**
-.127***
-.100***