

1 **Main Article**

2

3 **The role of leisure-time physical activity in youth for lifelong activity – A latent profile**  
4 **analysis with retrospective life course data**

5

6 Lars Lenze<sup>a,b</sup>, Claudia Klostermann<sup>b</sup>, Julia Schmid<sup>a</sup>, Markus Lamprecht<sup>c</sup>, Siegfried Nagel<sup>a</sup>

7

8 <sup>a</sup>Institute of Sport Science, University of Bern, Bern CH, 3012, Switzerland

9 <sup>b</sup>University of Teacher Education, University of Applied Sciences and Arts Northwestern

10 Switzerland, Windisch CH, 5210, Switzerland

11 <sup>c</sup>Lamprecht und Stamm Sozialforschung und Beratung, Zurich CH, 8032, Switzerland

12

13 *Corresponding author*

14 Lars Lenze

15 Bremgartenstrasse 145, CH-3012 Bern

16 email: lars.lenze@unibe.ch

17 ORCID: 0000-0001-7610-8913

18 **Abstract**

19 Considering the positive health effects of leisure-time physical activity (LTPA), youth is an  
20 important life stage to promote lifelong LTPA. However, the stability of LTPA over the life  
21 course is low, and specific predictors of LTPA in youth for lifelong activity have some  
22 shortcomings, e.g. neglecting the interacting factors of LTPA within individuals. Therefore, from  
23 a person-oriented approach, patterns of LTPA behaviour in youth considering time- and  
24 context-related aspects and their relationships with lifelong LTPA were investigated. Life  
25 course data from  $n = 1519$  Swiss inhabitants aged between 25 and 76 years were recorded  
26 retrospectively using a validated questionnaire (CATI-method). *Latent profile analyses* were  
27 used to find the optimal profile solution and for the association with lifelong LTPA *auxiliary*  
28 *conditional effect models* (controlled for age) were applied. Six distinct patterns emerged.  
29 Overall, mostly inactive youth are also the least active in adulthood, whereas several other  
30 patterns are associated with a mainly continuous LTPA throughout adulthood. More precisely,  
31 multiple constellations in youth occurred to be physically active in at least 80% of the years in  
32 adulthood: (1) early starters regarding LTPA in a rather self-organised setting but not with  
33 many different LTPAs; (2) late entrants with a variety of different activities and organisational  
34 settings; or (3) a high expression in every variable investigated. Consequently, there is not just  
35 one way of LTPA behaviour in youth linked to lifelong activity, which indicates that certain  
36 aspects of LTPA in youth can be compensated by each other. Implications for LTPA promotion  
37 can be derived.

38

39

40 **Keywords:**

41 sport participation, youth development, person-oriented approach, pattern, time-related and

42 context-related aspects

## 43 **1 Introduction**

44 Promoting regular and long-lasting leisure-time physical activity (LTPA) for a wide range of the  
45 population is a goal among various societal actors given the long-term health-promoting effects  
46 (Reiner et al., 2013) and the high health costs caused by physical inactivity (Ding et al., 2016).  
47 For this purpose, youth is a decisive life stage to shape later health behaviour (Sawyer et al.,  
48 2012) including lifelong LTPA (Kirk, 2005), which is supported by the general life course  
49 approach (Bernardi et al., 2019). Time-related interdependencies over the life course are  
50 assumed, which means that not only the recent past influences the present but also the far-  
51 away past (see *path dependency* in Bernardi et al., 2019). Hence, no single time points or  
52 single selected explanation factors can be examined; rather, their various interdependencies  
53 must be examined. Thus, it is important to consider a long period in order to understand and  
54 explain later outcomes in life. However, in studies investigating the association between  
55 differentiated factors of LTPA in youth and later LTPA in life, the measurement of lifelong LTPA  
56 was mostly recorded for only one time point in (young) adulthood. Thus, there is no information  
57 on long-term or even lifelong LTPA throughout adulthood. Another characteristic of the life  
58 course approach is the amount of time spent in certain situations, which is highly relevant for  
59 the further course of life (Mayer, 1990) and for LTPA: the longer continuously active in life, the  
60 lower the chance of becoming inactive (Engel and Nagel, 2011). Persistent exercising for at  
61 least three years in youth is a predictor for being later active in life (Batista et al., 2019). In  
62 addition, a long physically active period in youth can also be achieved by an early entry into  
63 LTPA, which is also predictive for later LTPA in life (Kjønniksen et al., 2009). The  
64 aforementioned time-related high involvement in LTPA, also referred to as the depth of  
65 activities, can be further supported by a high weekly frequency of LTPA in youth, which seems  
66 relevant for later LTPA in life as well (Batista et al., 2019).

67 In addition to time-related aspects, from a human development perspective, the context plays  
68 a decisive role to understand and explain behaviour and development (e.g. Lerner, 2006). This  
69 is also shown for LTPA in youth: specific types of activities (e.g. endurance sports, Kjønniksen  
70 et al., 2008; Tammelin et al., 2003), organised and often club-based activities (Kjønniksen et

71 al., 2009; Scheerder et al., 2006), self- and non-organised activities (Cleland et al., 2012;  
72 Scheerder et al., 2006) and competitions (Batista et al., 2019) are related to LTPA later in life.  
73 The number of different contexts represented by the number of different activities in youth,  
74 also called breadth of activities, is also promising for LTPA later in life (Engström, 2008;  
75 Cleland et al., 2012; Kjønniksen et al., 2008). Consequently, individuals choose environments  
76 to participate in LTPAs in specific contexts, which leads to multiple combinations of activities  
77 and the exposure to various contexts (Agans and Geldhof, 2012). Thus, there is not only one  
78 LTPA in one context in youth for conducive development (cf. Coakley, 2011); rather, activities  
79 and contexts are interrelated, and thus interactions within individuals occur (e.g. football can  
80 be played in a club or self-organised; cf. Gut et al., 2020, Zarrett et al., 2009). There are various  
81 such constellations in a population, i.e. inter-individual differences (e.g. some play football in  
82 a club, others play self-organised and others do both; e.g. Zarrett et al., 2009). Consequently,  
83 analysing separate variables or predictors of LTPA in youth fall short, also due to including  
84 only aggregate values on group levels (cf. Zarrett et al., 2009) and thus neglecting possible  
85 compensation effects (e.g. high values in certain variables can counterbalance low levels in  
86 other variables for lifelong LTPA) and synergistic effects (e.g. high levels of variables  
87 strengthen each other for lifelong LTPA) within an individual. Therefore, the person-oriented  
88 approach describing patterns of LTPA in youth seems promising (Bergman et al., 2003).  
89 Empirical studies that describe such patterns of LTPA in youth differ regarding the variables  
90 used for person-oriented analyses: (1) specific types or categories of activities (Agans and  
91 Geldhof, 2012; Borgers et al., 2015); (2) organisational settings differentiating between  
92 organised and self-organised settings (Gut et al., 2020, 2022; Lawler et al., 2017); and (3) the  
93 breadth (number of different activities) and depth (frequency/duration of activities) of activities  
94 (Agans et al., 2017). Klostermann and Nagel (2011) included the breadth and depth as well as  
95 the organisational setting but for the first 39 years of life—not in youth. However, the reported  
96 studies investigated patterns of LTPA in youth (except Klostermann and Nagel, 2011) but not  
97 the relationship with lifelong LTPA.

98 Several attempts at explanation were made to explain the relationship between LTPA in youth  
99 and lifelong LTPA. Telama (2009) formulated therefore hypotheses. For example, the *carry-*  
100 *over value hypothesis* means that specific types of physical activities learned in early years  
101 are continued in adulthood, also called lifestyle activities. In addition, the *ability and readiness*  
102 *hypothesis* indicates that early experiences of activities with basic skills facilitate the  
103 continuation of being physically active or to re-enter in the same or other activities. This  
104 hypothesis from Telama is similar to the early sampling approach (Côté et al., 2007), not for  
105 achieving later success in one activity but for later recreational participation, or in other words,  
106 for lifelong activity. Therefore, experiences with a broad range of activities ('sampling') in youth  
107 helps during the life course to start new activities, to continue given activities or to re-enter  
108 already practiced activities.

109 In summary, when investigating the relationship between LTPA in youth and lifelong LTPA, the  
110 following research desiderata should be considered: (1) no single time points or single selected  
111 explanation factors but rather the entire life course and interdependencies between time and  
112 explanation factors, (2) time-related and context-related information to represent LTPA  
113 behaviour in youth and (3) person-oriented analysis methods allowing for intra- and inter-  
114 individual interactions and differences. Moreover, (4) sociodemographic aspects such as sex,  
115 educational level, and age are well-known differentiation aspects of LTPA in youth (e.g. for  
116 Switzerland: Lamprecht et al., 2020) and should thus be taken into account. In this study, the  
117 aforementioned research desiderata are considered and three research questions (RQ) are  
118 defined:

119 RQ 1: Which patterns of time-related and context-related information about LTPA emerge in  
120 youth?

121 RQ 2: How can the emerged patterns further be described in regard to sociodemographic  
122 variables and specific types of LTPAs?

123 RQ 3: To what extent are the patterns from youth associated with lifelong LTPA?

124

125

126 **2 Materials and Methods**

127 *Design and sample*

128 This study is part of a project funded by the Swiss National Science Foundation and in  
129 collaboration with the federal survey 'Sport Schweiz 2020'. LTPA over the whole life course  
130 was recorded with a retrospective and validated questionnaire. More precisely, a retrospective  
131 telephone survey with computer-assisted telephone interviews (CATI-method) of Swiss  
132 inhabitants aged between 25 and 76 years was conducted in 2019. The random sample was  
133 recruited via the Federal Statistical Office and with persons from the panel of the survey  
134 institute. The questionnaire used is a further development of previous studies investigating  
135 LTPA during the life course (e.g. Klostermann and Nagel, 2011) and was tested qualitatively  
136 and quantitatively in multiple waves, including a separate reliability check with the test-retest-  
137 method ( $n = 29$ ; for a detailed description for the validation of the questionnaire, see Lenze et  
138 al., 2021). Using Krippendorff's alpha to consider multiple scale levels for the reliability check,  
139 all variables used showed good values ( $\alpha > .80$ ; Krippendorff, 2018; see specific values in  
140 Supplementary Table 1).

141 After conducting the survey, the data of each participant were checked carefully for internal  
142 consistency and discrepancies, which led to the exclusion of 222 participants, resulting in a  
143 final sample of  $n = 1519$  ( $n = 569$  from the Federal Statistical Office;  $n = 950$  from the panel of  
144 the survey institute).

145 The study was conducted according to the guidelines of the Declaration of Helsinki and was  
146 approved by the Ethics Committee of the University of Teacher Education, University of  
147 Applied Sciences and Arts Northwestern Switzerland (30 January 2019). Informed consent  
148 was obtained from all subjects involved in the study.

149

150 *Measures*

151 LTPA is understood as physical activities including exercise, sport and unstructured recreation  
152 and excludes domestic, occupational, and commuting physical activity (Khan et al., 2012; see  
153 Lenze et al., 2021 for a detailed description). In this article, the term *youth* relates to the first

154 20 years of one's life. To build patterns of LTPA behaviour in youth (RQ 1), four indicators  
155 considering time-related and context-related information were included and recorded up to the  
156 age of 20:

157 *Number of regularly active years.* The depth of activities was measured by regularly active  
158 years in terms of LTPA between 3 and 20 years of age. The term 'regular' refers to at least  
159 once a week. Thus, each regularly active year in the aforementioned age range was added  
160 per participant.

161 *Number of different activities practiced.* To cover the breadth of activities, each LTPA practiced  
162 at least multiple times per year for more than one year was included. The maximum number  
163 of different LTPAs was set to five.

164 *Self-organised activities.* LTPAs practiced regularly by oneself or with friends reflect one part  
165 of the organisational setting. This indicator was dummy coded if this organisational form was  
166 practiced (1) or not (0) in youth. The term 'self-organised' is equivalent to 'informal' or 'non-  
167 organised'.

168 *Organised activities.* Regular club-based LTPAs or at private sports providers (e.g. fitness  
169 centre, yoga or dance studio) comprise this part of the organisational setting. This was coded  
170 as a dummy variable if activities were practiced organised (1) or not (0) in youth.

171 To enrich the patterns with further relevant information regarding aspects affecting LTPA  
172 behaviour (RQ 2), sociodemographic variables and categories of specific types of LTPAs were  
173 included. *Sex, age at the time of the survey and educational level* were considered. The  
174 educational level is represented by a 5-level variable (1 compulsory school; 2 secondary  
175 school/ lower professional education; 3 higher professional education leaving certificate; 4  
176 technical college; 5 university). To provide insights into which types of LTPA were practiced in  
177 the respective pattern, ten *categories of types of LTPAs* from Sudeck et al. (2011) were used  
178 (1 walking and endurance activities; 2 fitness; 3 gymnastics and multi-sport activities; 4  
179 athletics; 5 compositional-creative activities; 6 release-oriented activities; 7 outdoor- and  
180 mountain activities; 8 sports games; 9 martial arts; 10 equestrian).



181 Concerning lifelong LTPA (RQ 3), an *index of lifelong LTPA* with the ratio of physically active  
182 and inactive years in adulthood was developed for each participant. Due to the broad age  
183 range at the time of the survey, a comparable score was calculated from 21 years until the age  
184 at time of the survey of each person (ratio of regularly active years divided by the years of life  
185 from 21 upwards). This index reflects LTPA throughout adulthood.

186

### 187 *Data preparation and analyses*

188 To identify patterns of LTPA in youth (RQ 1), latent profile analyses (LPA) with four indicators  
189 were conducted (Masyn, 2013). This procedure allows to integrate continuous and categorical  
190 variables as indicators. In this study, two indicators (*number of regularly active years* and  
191 *number of different activities practiced*) were used as continuous variables, whereas the other  
192 two indicators (*self-organised activities* and *organised activities*) were applied as categorical  
193 variables. One to eight profiles were calculated. To find the optimal number of profiles, a mix  
194 between content-related and statistical criteria were used. The content-related criteria included  
195 theory-based considerations, clear qualitative differences between profiles, the principle of  
196 parsimony and a lack of small profiles (<5% of the sample) (Masyn, 2013; Morin and Wang,  
197 2016). In contrast, the statistical criteria comprised the screening of the log likelihood value  
198 (LL), Akaike information criterion (AIC), consistent AIC (CAIC), Bayesian information criterion  
199 (BIC), sample-sized adjusted BIC (SABIC), bootstrap likelihood ratio test (BLRT) and the  
200 Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR) (Marsh et al., 2009; Masyn, 2013; Morin  
201 and Wang, 2016). Due to large sample sizes, adding a profile often yields significant BLRT  
202 and VLMRT as well as lower AIC, CAIC, BIC, and SABIC values (Marsh et al., 2009). Thus,  
203 the separate fit-indices provide no adequate measures and the elbow plot of the fit-indices  
204 must be taken into account (Morin & Wang, 2016). For the further description of the patterns  
205 (RQ 2), the means of the sociodemographic variables (sex, age, educational level) per pattern  
206 were taken and the Wald test was used to identify significant differences between the patterns  
207 ( $p$ -value < .01). The interpretation of the differences between the patterns was further

208 described by effect sizes (Cohen's  $d$ :  $\geq 0.20$  small effect,  $\geq 0.50$  medium effect,  $\geq 0.80$  large  
209 effect; Cohen, 1988).

210 To model the relationship between profile memberships and the index of lifelong LTPA  
211 controlling for age, auxiliary conditional effects models (similar to an ANCOVA, McLarnon and  
212 O'Neill, 2018) were applied. Controlling for age was important as age-related differences in the  
213 life course can occur, which is already partly considered in the index of lifelong LTPA. To  
214 interpret the mean differences between profiles, again the Wald test indicated significance ( $p$ -  
215 value  $< .01$ ), and the Cohen's  $d$  indicated effect size. All analyses were performed with Mplus  
216 (Muthen and Muthen, 1998-2017) using the maximum likelihood estimation with robust  
217 standard errors.

218

219

## 220 **3 Results**

### 221 *Sample characteristics*

222 The mean age at the time of the survey of the  $n = 1519$  participants was  $59.2 \pm 11.75$  years  
223 and 947 women (62.3 %) were in the sample. Regarding the educational level, the mean of  
224 the 5-level scale (1–5) was exactly  $3 \pm 1.22$ . Further general sample characteristics can be  
225 found in Supplementary Table 2. The means of the indicators and the index of lifelong LTPA  
226 are presented in Supplementary Table 3. Regarding the specific types of LTPAs, the first two  
227 columns in Supplementary Table 4 reflect the frequencies in the ten categories.

228

### 229 *The optimal profile solution*

230 In a first step, the optimal number of profiles had to be determined. Therefore, the fit-indices  
231 for one to eight profiles are shown in Supplementary Table 5. On Supplementary Figure 1, the  
232 fit-indices are plotted and the best-fitting solution is provided by the profile after which the slope  
233 flattens out. Therefore, five to seven profiles seemed to fit best. Considering content-related  
234 criteria, in terms of parsimony the five-profile solution would have been favored. But regarding  
235 the qualitative differences within profile solutions, the six-profile solution showed more distinct

236 patterns (see Figure 1) in comparison to the five and seven profile solutions (not shown).  
237 Furthermore, rather in the six-profile solution than in the five-profile solution theoretically  
238 plausible profiles emerged, and no profiles with less than 5% of the sample occurred.  
239 Altogether, the six-profile solution was seen as the best-fitting solution considering all criteria  
240 mentioned. This solution also showed a high value of the classification precision (Entropy =  
241 .86; see Supplementary Table 5).

242

#### 243 *Description of the profiles*

244 Based on RQ 1, the six profiles are plotted in Figure 1. Table 1 shows per profile values of the  
245 indicators and sociodemographic information, and the categories of types of LTPAs are  
246 presented in Supplementary Table 4 (RQ 2).

247

248 **--- Insert Figure 1 here ---**

249

250 In the following paragraphs, each profile is described by indicators (RQ 1) and further variables  
251 (RQ 2). Regarding the sociodemographic information as further variables, the significant  
252 differences and effect sizes between the profiles are shown in the Supplementary Tables 6-8.  
253 Overall, despite a lot of significant differences between the profiles which might be caused by  
254 the large sample size, the effect sizes were negligible to small. Only one difference per  
255 sociodemographic variable revealed a moderate effect size (see Supplementary Tables 6-8).  
256 Profile 1 is called *mostly inactive youth* and includes participants who were inactive or very low  
257 active in youth. Compared to the other profiles, more women are in this profile, they are on  
258 average older, and lower educated. The *very diversely active early starters* reflect profile 2.  
259 This largest profile contains high and above-average values for all indicators. Thus, people of  
260 this profile started early in life with regular LTPAs and practiced several different activities in  
261 organised as well as self-organised settings. They are on average younger, higher educated  
262 and practiced each category of specific types of LTPAs above-average, especially walking and  
263 endurance activities, outdoor- and mountain activities and sports games. Profile 3 includes the

264 *very diversely active late entrants*. This profile is quite similar to profile 2 with one difference:  
265 People in profile 3 did not have that many regularly active years during youth and are therefore  
266 called late entrants. Furthermore, in comparison to the other profiles, they are very often men  
267 and showed a very similar distribution of specific types LTPAs practiced as profile 2. The *low*  
268 *diversely active, self-organised early starters* in profile 4 began very early with regular LTPA  
269 but did not practice many different LTPAs in a self-organised and in a partially organised  
270 setting. Compared to the other profiles, many women are in this profile, and they were  
271 predominantly active in walking and endurance activities as well as outdoor- and mountain  
272 activities, but not frequently in sports games. Profile 5 represents the *low diversely active late*  
273 *entrants*. This profile is characterised by few regularly active years in few different LTPAs  
274 (primarily walking and endurance activities and outdoor- and mountain activities) partially  
275 practiced in self-organised and organised settings. Profile 6 is the *low diversely active,*  
276 *organised early starters*. People in this profile practiced few different LTPAs in an organised  
277 setting and entered LTPA rather early in youth. They practiced mainly sports games and  
278 comparatively less walking and endurance activities or outdoor- and mountain activities.

279

280

--- Insert Table 1 here ---

281

282 *The association between the profiles and lifelong LTPA*

283 Regarding RQ 3, Figure 2 reveals the *Index of lifelong LTPA* per profile including significant  
284 differences and effect sizes, controlled for age. The most active people in adulthood were the  
285 *low diversely active, self-organised early starters* (profile 4, index = 0.85) and the *very diversely*  
286 *active early starters* (profile 2, index = 0.84). They were significantly more active than people  
287 from profile 1 with a medium effect size (for profile 4:  $p < .001$ ,  $d = 0.7$ ; for profile 2:  $p < .001$ ,  
288  $d = 0.57$ ) and also significantly more active with a very small effect size than people from profile  
289 5 (for profile 4:  $p < .001$ ,  $d = 0.16$ ; for profile 2:  $p < .001$ ,  $d = 0.12$ ) and profile 6 (for profile 4:  $p$   
290  $< .01$ ,  $d = 0.11$ ; for profile 2:  $p < .01$ ,  $d = 0.08$ ). Also mostly active in adulthood were the *very*  
291 *diversely active late entrants* (profile 3, index = 0.82), the *low diversely active, organised early*

292 *starters* (profile 6, index = 0.79) and the *low diversely active late entrants* (profile 5, index =  
293 0.76). They were all significantly more active with a medium effect size compared to people  
294 from profile 1 (for profile 3:  $p < .001$ ,  $d = 0.66$ ; for profile 6:  $p < .001$ ,  $d = 0.6$ ; for profile 5,  $p <$   
295  $.001$ ,  $d = 0.55$ ). The *mostly inactive youth* (profile 1) had the lowest activity ratio in adulthood  
296 (index = 0.47).

297

298

--- Insert Figure 2 here ---

299

300

#### 301 **4 Discussion**

302 The present study investigated the LTPA behaviour in relation to time- and context related  
303 aspects in youth and the association to lifelong LTPA in adulthood. Using retrospective life  
304 course data with a validated questionnaire and a person-oriented approach, qualitatively  
305 distinct patterns of LTPA in youth emerged. These patterns are related to different levels of  
306 lifelong LTPA in adulthood.

307

##### 308 *Patterns of LTPA in youth*

309 Time- and context-related aspects of LTPA in youth were applied to build patterns of LTPA  
310 behaviours. In the person-oriented approach used, the relevant variables can interact within  
311 individuals and can differ between individuals (Bergman et al., 2003), describing the  
312 heterogeneity of LTPA behaviours occurring in youth by identifying homogeneous subgroups  
313 (e.g., Gut et al., 2020). Based on the profiles, similarities to other studies can only be identified  
314 to a certain extent as the indicators used have never been studied in this context. Nevertheless,  
315 the *mostly inactive youth* (profile 1) emerged in other studies as well (Agans et al., 2017; Gut  
316 et al., 2020, 2022; Lawler et al., 2017). A simultaneously high level of breadth and depth of  
317 LTPA, similar to individuals in profile 2, has already been identified by Agans and colleagues  
318 (2017). Furthermore, doing LTPA in self-organised and organised settings (people in profiles  
319 2 and 3) was already shown by Lawler et al. (2017), although profiles 2 and 3 differ regarding

320 the depth of activities. Practicing LTPA in a predominantly self-organised setting (profile 4) has  
321 also been shown by other studies (Gut et al., 2020, 2022; Lawler et al., 2017), and conversely,  
322 doing LTPA in a predominantly organised setting (profile 6) has similarly been found by other  
323 research (Agans and Geldhof, 2012; Borgers et al., 2015; Gut et al., 2020, 2022; Lawler et al.,  
324 2017). Our data indicate that focusing on one organisational setting (profiles 4 & 6) was  
325 associated with practicing few different LTPAs. Consequently, following the already introduced  
326 understanding of human development (Lerner, 2006), the context of behaviour plays an  
327 important role for development in youth activities too (Zarrett et al., 2009). The patterns found  
328 in this study revealed that practicing LTPA can occur in a variety of contexts – between and  
329 within individuals. This is reflected in our patterns by differing the organisational setting and  
330 the breadth of activities as well as the depth of activities.

331

### 332 *Relationship between LTPA in youth and lifelong LTPA*

333 Regarding the relationships with lifelong LTPA, the assumption of dependencies over the life  
334 course (Bernardi et al., 2019) can be supported by our data. Furthermore, in line with the  
335 understanding of human development (e.g. Lerner, 2006), there is not one activity according  
336 to LTPA in youth for conducive development (cf. Coakley, 2011) but inter-individual differences  
337 in LTPA behaviours in youth. Thus, there are different ways to achieve a high level of lifelong  
338 LTPA, such as having high values of all indicators (profile 2) or high levels of at least two  
339 indicators (profiles 3, 4, & 6). If the *number of regularly active years* and the *number of different*  
340 *activities practiced* was rather low in youth, it is more difficult to achieve many active years in  
341 adulthood (profile 5). And mostly inactive people in youth were clearly the least active in  
342 adulthood (profile 1). Regarding the well-known social inequalities in practicing LTPA and  
343 sports (e.g. Rohrer & Haller, 2015; Scheerder et al., 2002), profile 1 displayed a comparatively  
344 low educational level and high proportion of women, whereas profile 5 with the second-lowest  
345 index of lifelong LTPA did not reflect these social differences. In addition, for example,  
346 individuals in profile 4 with the highest activity index over the life course had the second-lowest  
347 value regarding educational level and the second-highest proportion of women. Consequently,

348 social inequalities cannot systematically explain the relationship between the LTPA behaviour  
349 in youth and lifelong activity.

350 Considering the differently shaped profiles in youth, it appears that certain indicators can  
351 compensate for each other. More specifically, it is evident that a high level of either *number of*  
352 *regularly active years (> 13)* or *number of different activities practiced (> 4)* in youth is crucial  
353 to becoming physically active in 80% of the years lived in adulthood (*Index of lifelong LTPA >*  
354 *0.80*, see profiles 2, 3, 4). Thus, a high value of one of these indicators seems important, but  
355 they can compensate for each other. The importance of these two indicators is supported by  
356 variable-oriented studies (e.g., correlation or regression analyses) investigating them  
357 separately as predictors for lifelong LTPA (Batista et al., 2019; Engström, 2008; Cleland et al.,  
358 2012; Kjønniksen et al., 2008), which leads to the conclusion that a high value for both  
359 variables in youth is beneficial for lifelong LTPA. Our data also showed that a high value in  
360 both variables is beneficial (profile 2), indicating a synergistic effect; however, a compensation  
361 mechanism (profiles 3 and 4, and to some extent profile 6) is possible as well. From a  
362 theoretical understanding, the importance of the breadth of activities in youth is in line with the  
363 early sampling approach (Côté et al., 2007) and the *ability and readiness hypothesis* (Telama,  
364 2009). The relevance of an early start respectively many physically active years in youth is  
365 accompanied by time-related dependencies in the life course approach, more precisely the  
366 amount of time spent in certain situations or states influences the further course of life (Mayer,  
367 1990), and in the meaning of an early socialisation, early-onset experiences in youth are  
368 relevant for shaping lifelong behaviour (Kirk, 2005; Sawyer et al., 2012). Furthermore,  
369 regarding organisational settings, being physically active in both settings (organised and self-  
370 organised) seems promising regarding lifelong LTPA (see profile 2 and 3), whereas practicing  
371 it in a predominantly self-organised setting goes hand-in-hand with a high activity index in  
372 adulthood as well (profile 4). However, being physically active only in an organised setting in  
373 youth reduced the likelihood to become comparatively very active during adulthood (see profile  
374 6). A possible explanation could be that in adulthood, a more self-organised setting is preferred  
375 (Eime et al., 2015; 2020), and thus the organisational change from an only organised setting

376 in youth to a rather self-organised setting in adulthood is accompanied by less activity. The  
377 most frequently practiced activities in profile 6 are sports games, predominantly practiced in a  
378 club, and maybe such activities are more difficult to continue in a rather self-organised setting  
379 in adulthood (cf. Downward et al., 2014). This could be an explanation for why the *low diversely*  
380 *active, self-organised early starters* (profile 4) are slightly more active during adulthood. In  
381 addition, the *carry-over value hypothesis* (Telama, 2009) may explain the relationship between  
382 practicing in a self-organised context in youth and the high level of LTPA during adulthood  
383 insofar as so-called lifetime activities (e.g. skiing, swimming or cycling; see categories walking  
384 and endurance activities and outdoor- and mountain activities in Supplementary Table 4) were  
385 practiced in this setting and can easily be continued during adulthood (see profile 4, but also  
386 profiles 2 and 3).

387 Overall, it should be noted that the differences regarding LTPA during adulthood between  
388 profiles 2 to 6 were low. However, when looking at the differences between the profiles 2 to 6  
389 and profile 1, the differences were higher with medium effect sizes. Consequently, to stay  
390 active in adulthood any kind of regular LTPA in youth is better, respectively linked to a higher  
391 probability, than none. Yet, some profiles are particularly promising in order to reach a mainly  
392 continuous LTPA throughout adulthood.

393

#### 394 *Limitations and future research*

395 Some limitations must be considered for this study. LTPA was measured by self-report and  
396 retrospectively. Considering this method is not the most valid with a tendency to overestimate  
397 physical activity (Ainsworth & Levy, 2004), efforts were made to gather the most reliable and  
398 valid data possible (e.g. reliability test, see Lenze et al., 2021 for further information). Likewise,  
399 the frequency and intensity of LTPA were not captured due to the inaccuracy of measuring  
400 them in retrospective studies (Ropponen et al., 2001); rather, the regular practice of LTPA in  
401 terms of years was captured. Related to this, we are aware that older adults are more prone  
402 to a possible recall bias. However, our reliability test including older adults revealed good  
403 reliability values (see Supplementary Table 1). In addition, the activity level of the sample



404 regarding LTPA was slightly higher than for the population in Switzerland (see Lamprecht et  
405 al., 2020), but a broad range of the Swiss population was covered with the aim of describing  
406 associations in general while not drawing conclusions about the entire population. Moreover,  
407 the sample of this study contained a broad age range, meaning that not all participants have  
408 already experienced the same life stages. To counteract this, the age of the participants was  
409 controlled for the analysis with lifelong LTPA, but not for the profile analysis. However,  
410 associated to this, a time-historical effect for the broad age range in this sample cannot be  
411 ruled out. Further sociodemographic variables such as sex and educational level were not  
412 directly controlled for but showed no systematic effect regarding the relationship to lifelong  
413 LTPA, as previously mentioned. Furthermore, the indicators used for the profile analyses were  
414 carefully deduced theoretically and empirically and comprise a broad spectrum of LTPA  
415 behaviours in relation to time- and context-related aspects over the first 20 years of life from a  
416 mainly sociological perspective, but they reflect not detailed and highly differentiated LTPA  
417 behaviours, such as specific organised settings of LTPA (e.g. sport club, fitness centre) or  
418 psychological aspects of LTPA (e.g. motivation, see Schmid et al., 2020). Lastly, our data  
419 reflect the sport system and culture over several decades in Switzerland, and therefore caution  
420 is required for a generalisation to other countries.

421 These limitations must be considered for implications, and consequently, future research  
422 should examine the results found with prospective data, other aspects of LTPA behaviour and  
423 in other countries to determine whether similar patterns and relationships to LTPA over the life  
424 course would emerge and to better understand the interdependencies over the life course.

425

#### 426 *Conclusion*

427 In terms of LTPA, being mostly inactive in youth was associated with low lifelong activity,  
428 whereas various profiles of LTPA in youth were related to a high or very high activity index  
429 over the life course. Thus, there is not just one way for lifelong activity. Considering interacting  
430 time- and context-related factors within persons and inter-individual differences, multiple  
431 constellations in youth were associated with a very high activity index throughout life: a high

432 value for each indicator; either a high depth or breadth of activities, combined with multiple  
433 organisational settings or particularly with a self-organised, and somewhat less with an  
434 organised setting. Thus, the findings of this study prove beneficial for the promotion of LTPA  
435 in youth and consequently over the entire life course.

436 **Acknowledgments**

437 The study was funded by the Swiss National Science Foundation (SNSF) under Grant number  
438 10001A\_182687. The authors thank Dr Juerg Schmid and Dr Takuya Yanagida for their  
439 support in carrying out the statistical analyses.

440

441 **Disclosure statement**

442 The authors declare that they have no competing interests.

443

444 **Data availability statement**

445 The data that support the findings of this study are available from the corresponding author,  
446 [LL], upon reasonable request.

447

448 **References**

- 449 Agans, J. P., & Geldhof, G. J. (2012). Trajectories of participation in athletics and positive youth  
450 development: The influence of sport type. *Applied Developmental Science, 16*(3),  
451 151–165.
- 452 Agans, J. P., Johnson, S. K., & Lerner, R. M. (2017). Adolescent athletic participation patterns  
453 and self-perceived competence: Associations with later participation, depressive  
454 symptoms, and health. *Journal of Research on Adolescence, 27*(3), 594–610.
- 455 Ainsworth, B. E., & Levy, S. S. (2004). Assessment of health-enhancing physical activity:  
456 Methodological issues. In P. Oja & J. Borms (Eds.), *Health Enhancing Physical*  
457 *Activity* (pp. 239–270). Meyer and Meyer.
- 458 Batista, M. B., Romanzini, C. L. P., Barbosa, C. C. L., Blasquez Shigaki, G., Romanzini, M., &  
459 Ronque, E. R. V. (2019). Participation in sports in childhood and adolescence and  
460 physical activity in adulthood: A systematic review. *Journal of Sports Sciences,*  
461 *37*(19), 2253–2262.
- 462 Bergman, L. R., Magnusson, D., & El-Khoury, B. M. (2003). *Studying individual development*  
463 *in an interindividual context. A person-oriented approach* (Paths through life, 4).  
464 Erlbaum.
- 465 Bernardi, L., Huinink, J., & Settersten R. A. (2019). The life course cube: A tool for studying  
466 lives. *Advances in Life Course Research, 41*, 100258.
- 467 Borgers, J., Thibaut, E., Vandermeerschen, H., Vanreusel, B., Vos, S., & Scheerder, J. (2015).  
468 Sports participation styles revisited: A time-trend study in Belgium from the 1970s to  
469 the 2000s. *International Review for the Sociology of Sport, 50*(1), 45–63.
- 470 Cleland, V., Dwyer, T., & Venn, A. (2012). Which domains of childhood physical activity predict  
471 physical activity in adulthood? A 20-year prospective tracking study. *British Journal of*  
472 *Sports Medicine, 46*(8), 595–602.
- 473 Coakley, J. (2011). Youth sports: What counts as “positive development?”. *Journal of Sport*  
474 *and Social Issues, 35*(3), 306–324.

- 475 Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence  
476 Erlbaum Associates.
- 477 Côté, J., Baker, J., & Abernethy, B. (2007). Practice and play in the development of sport  
478 expertise. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of Sport Psychology*  
479 (3rd ed., pp. 184–202). Hoboken.
- 480 Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., Van  
481 Mechelen, W., ... & Lancet Physical Activity Series 2 Executive Committee. (2016).  
482 The economic burden of physical inactivity: A global analysis of major non-  
483 communicable diseases. *The Lancet*, *388*(10051), 1311–1324.
- 484 Downward, P., Lera-Lopez, F., & Rasciute, S. (2014). The correlates of sports participation in  
485 Europe. *European Journal of Sport Science*, *14*(6), 592–602.
- 486 Eime, R. M., Sawyer, N., Harvey, J. T., Casey, M. M., Westerbeek, H., & Payne, W. R. (2015).  
487 Integrating public health and sport management: Sport participation trends 2001–  
488 2010. *Sport Management Review*, *18*(2), 207–217.
- 489 Eime R. M., Harvey, J. T., & Charity, M. (2020). Sport participation settings: Where and “how”  
490 do Australians play sport? *BMC Public Health*, *20*(1), 1–9.
- 491 Engel, C., & Nagel, S. (2011). Sports participation during the life course. *European Journal for*  
492 *Sport and Society*, *8*(1–2), 45–63.
- 493 Engström, L. M. (2008). Who is physically active? Cultural capital and sport participation from  
494 adolescence to middle age. A 38-year follow-up study. *Physical Education and Sport*  
495 *Pedagogy*, *13*, 319–343.
- 496 Gut, V., Schmid, J., & Conzelmann, A. (2020). The interaction of behavioral context and  
497 motivational-volitional factors for exercise and sport in adolescence: Patterns  
498 matter. *BMC Public Health*, *20*(1), 1–14.
- 499 Gut, V., Schmid, J., Imbach, L., & Conzelmann, A. (2022). Stability of context in sport and  
500 exercise across educational transitions in adolescence: hello work, goodbye sport  
501 club? *BMC Public Health*, *22*(1), 1–15.

- 502 Khan, K. M., Thompson, A. M., Blair, S. N., Sallis, J. F., Powell, K. E., Bull, F. C., & Bauman,  
503 A. E. (2012). Sport and exercise as contributors to the health of nations. *The Lancet*,  
504 380(9836), 59–64.
- 505 Kirk, D. (2005). Physical education, youth sport and lifelong participation: The importance of  
506 early learning experiences. *European Physical Education Review*, 11(3), 239–255.
- 507 Kjønniksen, L., Anderssen, N., & Wold, B. (2009). Organized youth sport as a predictor of  
508 physical activity in adulthood. *Scandinavian Journal of Medicine and Science in*  
509 *Sports*, 19(5), 646–654.
- 510 Kjønniksen, L., Torsheim, T., & Wold, B. (2008). Tracking of leisure-time physical activity  
511 during adolescence and young adulthood: A 10-year longitudinal study. *International*  
512 *Journal of Behavioral Nutrition and Physical Activity*, 5(1), 1–11.
- 513 Klostermann, C., & Nagel, S. (2011). Sport treiben ein Leben lang? Einfluss der Sportkarriere  
514 der 1.Lebenshälfte auf das Sportengagement im mittleren und späten  
515 Erwachsenenleben [Practicing sports throughout life? Influence of the 1st half of life  
516 sports career on sports engagement in middle and late adulthood].  
517 *Sportwissenschaft*, 41(3), 216–232.
- 518 Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Sage  
519 publications.
- 520 Lamprecht, M., Bürgi, R., & Stamm, H. (2020). *Sport Schweiz 2020: Sportaktivität und*  
521 *Sportinteresse der Schweizer Bevölkerung [Sport Switzerland 2020: sports*  
522 *participation and sports interest of the Swiss population]*. Magglingen: Bundesamt für  
523 Sport BASPO.
- 524 Lawler, M., Heary, C., & Nixon, E. (2017). Variations in adolescents' motivational  
525 characteristics across gender and physical activity patterns: A latent class analysis  
526 approach. *BMC Public Health*, 17(1), 1–13.
- 527 Lenze, L., Klostermann, C., Lamprecht, M., & Nagel, S. (2021). Taking up and terminating  
528 leisure-time physical activity over the life course: The role of life events in the familial

529 and occupational life domains. *International Journal of Environmental Research and*  
530 *Public Health*, 18, 9809.

531 Lerner, R. M. (2006). Developmental science, developmental systems, and contemporary  
532 theories of human development. In W. Damon & R. Lerner (Eds.), *Handbook of child*  
533 *psychology* (Vol. 1, 6<sup>th</sup> ed., pp. 1–17). Wiley/John Wiley.

534 Marsh, H. W., Lüdtke, O., Trautwein, U., & Morin, A. J. (2009). Classical latent profile analysis  
535 of academic self-concept dimensions: Synergy of person- and variable-centered  
536 approaches to theoretical models of self-concept. *Structural Equation Modeling: A*  
537 *Multidisciplinary Journal*, 16(2), 191–225.

538 Masyn, K. E. (2013). Latent class analysis and finite mixture modeling. In T. D. Little (Ed.), *The*  
539 *Oxford handbook of quantitative methods in psychology: Vol. 2: Statistical analysis*  
540 (pp. 551–611). Oxford University Press.

541 Mayer, K. U. (1990). Lebensläufe und sozialer Wandel. Anmerkungen zu einem  
542 Forschungsprogramm [Life courses and social change. remarks on a research  
543 program]. In K. U. Mayer (Ed.), *Lebensverläufe und sozialer Wandel* (Kölner  
544 Zeitschrift für Soziologie und Sozialpsychologie, Sonderheft 31/1990, 7–21).  
545 Westdeutscher Verlag.

546 McLarnon, M. J., & O'Neill, T. A. (2018). Extensions of auxiliary variable approaches for the  
547 investigation of mediation, moderation, and conditional effects in mixture models.  
548 *Organizational Research Methods*, 21(4), 955–982.

549 Morin, A. J. S., & Wang, C. K. J. (2016). A gentle introduction to mixture modeling using  
550 physical fitness performance data. In N. Ntoumanis & N. Myers (Eds.), *An introduction*  
551 *to intermediate and advanced statistical analyses for sport and exercise scientists*  
552 (pp. 195–220). Wiley.

553 Muthén, L. K., & Muthén, B. O. (1998–2017). Mplus user's guide. Los Angeles.

554 Reiner, M., Niermann, C., Jekauc, D., & Woll, A. (2013). Long-term health benefits of physical  
555 activity—A systematic review of longitudinal studies, *BMC Public Health*, 13(1), 1–9.

- 556 Rohrer, T., & Haller, M. (2015). Sport und soziale Ungleichheit – Neue Befunde aus dem  
557 internationalen Vergleich [Sport and social inequality – new findings from international  
558 comparison]. *KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 67(1),  
559 57–82.
- 560 Ropponen, A., Levälähti, E., Simonen, R., Videman, T., & Battié, M. C. (2001). Repeatability  
561 of lifetime exercise reporting. *Scandinavian Journal of Medicine & Science in  
562 Sports*, 11(3), 185–192.
- 563 Sawyer, S. M., Afifi, R. A., Bearinger, L. H., Blakemore, S. J., Dick, B., Ezeh, A. C., & Patton,  
564 G. C. (2012). Adolescence: a foundation for future health. *The Lancet*, 379(9826),  
565 1630–1640.
- 566 Scheerder, J., Thomis, M., Vanreusel, B., Lefevre, J., Renson, R., Vanden Eynde, B., &  
567 Beunen, G. (2006). Sport participation among females from adolescence to  
568 adulthood. A longitudinal study. *International Review for the Sociology of Sport*, 41,  
569 413–430.
- 570 Scheerder, J., Vanreusel, B., Taks, M., & renson, R. (2002). Social sports stratification in  
571 Flanders 1969–1999: Intergenerational reproduction of social inequalities?  
572 *International Review for the Sociology of Sport*, 37(2), 219–245.
- 573 Schmid, J., Gut, V., Yanagida, T., & Conzelmann, A. (2020). Who stays on? The link between  
574 psychosocial patterns and changes in exercise and sport behaviour when  
575 adolescents make transitions in education. *Applied Psychology: Health and Well-  
576 Being*, 12(2), 312–334.
- 577 Sudeck, G., Lehnert, K., & Conzelmann, A. (2011). Motivbasierte Sporttypen [Motiv-based  
578 sport types]. *Zeitschrift für Sportpsychologie*, 18(1), 1–17.
- 579 Tammelin, T., Näyhä, S., Hills, A. P., & Järvelin, M.–R. (2003). Adolescent participation in  
580 sports and adult physical activity. *American Journal of Preventive Medicine*, 24, 22–  
581 28.
- 582 Telama, R. (2009). Tracking of physical activity from childhood to adulthood: A review. *The  
583 European Journal of Obesity*, 3, 187–195.





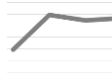



584 Zarrett, N., Fay, K., Li, Y., Carrano, J., Phelps, E., & Lerner, R. M. (2009). More than child's  
585 play: Variable-and pattern-centered approaches for examining effects of sports  
586 participation on youth development. *Developmental Psychology*, 45(2), 368.  
587

588 **Supplementary Material**

589 → *Supplementary Material is in a separate document*

590  
591

**Table 1** Description of the six profiles with indicators for the latent profile analysis (LPA) and further descriptive values ( $n = 1519$ )

Variables	 Profile 1	 Profile 2	 Profile 3	 Profile 4	 Profile 5	 Profile 6	Entire sample
<i>n</i> (%)	293 (19.3 %)	473 (31.1 %)	117 (7.7 %)	187 (12.3 %)	220 (14.5 %)	229 (15.1 %)	1519 (100 %)
<i>Four Indicators for the LPA</i>							
Number of regularly active years (0-18)	0.05	13.53	5.29	13.62	3.46	11.54	8.5
Number of different activities practiced (0-5)	0.32	4.41	4.19	1.92	1.94	1.93	2.55
Self-organised activities <sup>a</sup> (%)	2.9 %	77.6 %	73.9 %	> 99 %	62.3 %	0.9 %	53 %
Organised activities <sup>a</sup> (%)	0.2 %	89.4 %	77.6 %	37.9 %	51.1 %	> 99 %	61 %
<i>Sociodemographic values<sup>b</sup></i>							
<i>n</i> female (%)	226 (77.1 %)	275 (58.1 %)	60 (51.3 %)	142 (75.9 %)	120 (54.5 %)	124 (54.1 %)	947 (62.3 %)
Age (at time of the survey)	63.37	55.78	59.86	59.59	60.84	58.88	59.2
Educational level (1-5)	2.54	3.27	3.11	2.9	2.93	3.16	3.0

592  
593  
594

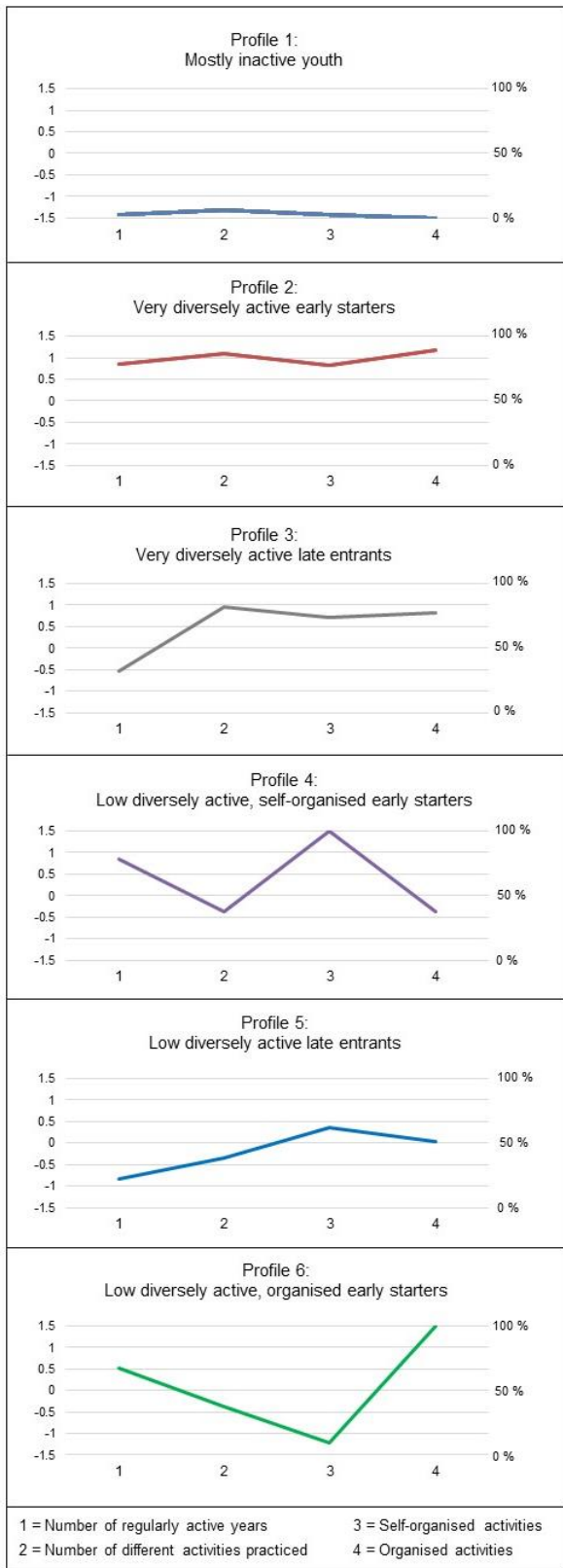
Note: Means per profile are provided, the last column relates to the means of the whole sample to compare the values better directly from the profiles. Additional descriptive information for the whole sample can be found in Supplementary Table 1 and Supplementary Table 3.

595  
596  
597

<sup>a</sup>The percentages mean the proportion of people practicing LTPA in the given organisational setting compared to not practicing LTPA in this setting. This is equivalent to the probability of practicing LTPA in this organisational setting.

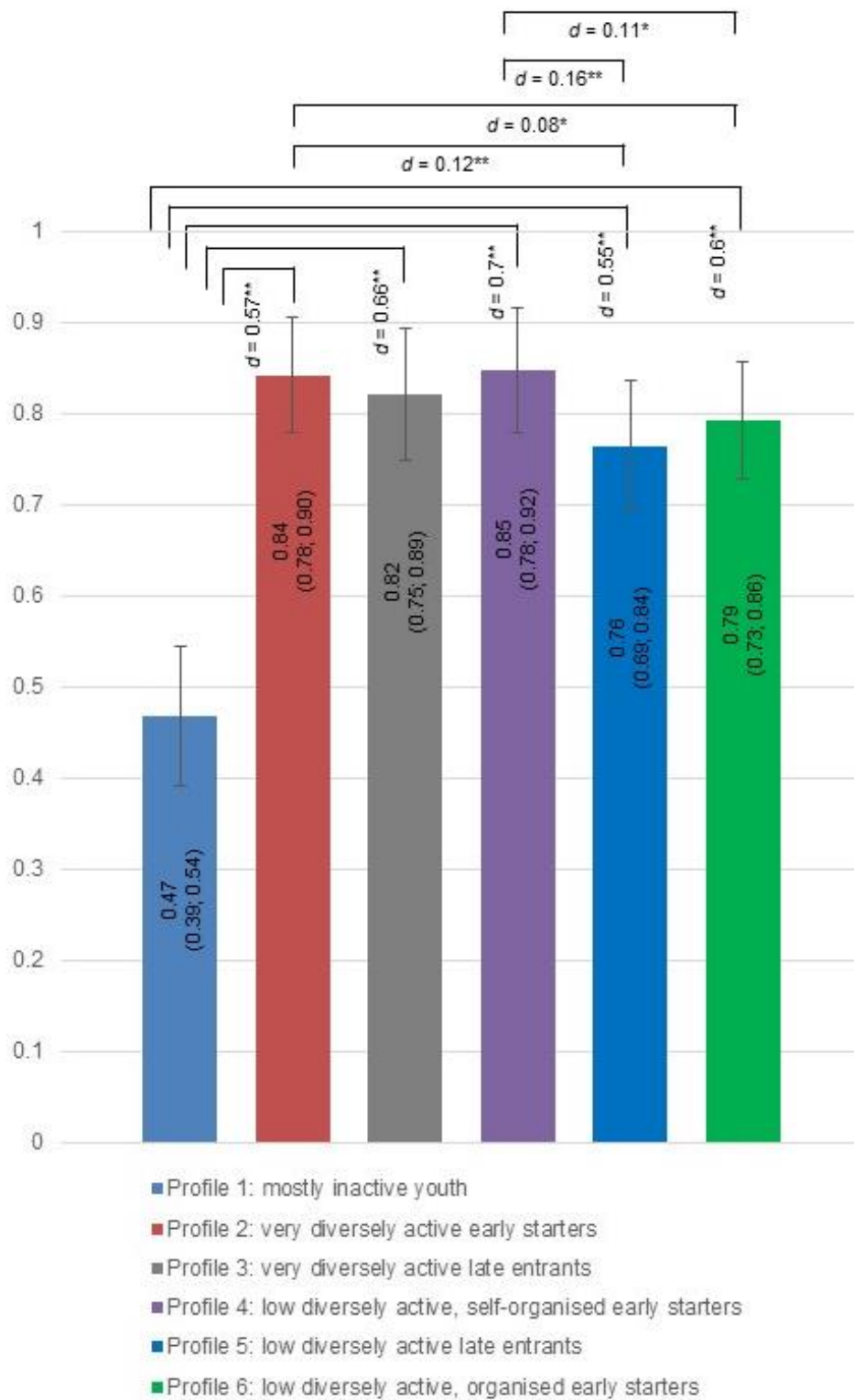
598  
599

<sup>b</sup>Statistical differences of the sociodemographic values between the respective profiles are shown in Supplementary Tables 6–8.



600

601 **Fig. 1** Plots of the six profiles. The left-sided y-axis displays z-scores of the first two  
 602 indicators (number of regularly active years and number of different activities practiced),  
 603 whereas the right-sided y-axis shows the percentages of people who practiced LTPA in this  
 604 organisational setting for the third (self-organised activities) and fourth (organised activities)  
 605 indicators



606

607 **Fig. 2** Means and 95% confidence intervals of the *Index of the lifelong LTPA* per profile,  
 608 controlled for age. Comparisons between profiles contain the significance levels  $*p < .01$ ;  $**p$   
 609  $< .001$  and effect sizes of Cohen's  $d$