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The Happiness Workout

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Abstract This study tests for causality from exercise and physical activity to life satisfaction (LS) by applying an instrumental variable approach with the respondents' perceived benefits of exercise participation as instruments. Using data across 25 countries from the Eurobarometer survey, our results confirm the positive association between exercise and LS. In terms of causality, the results indicate that being active increases LS for both gender, though more for men than women. One main reason for this relationship is that exercise is perceived as being pleasurable, something that policy-makers should keep in mind when designing programmes to get us off the sofa.

Keywords Subjective well-being · Life satisfaction · Happiness · Physical activity · Sport

1 Introduction

Unhealthy diets and sedentary lifestyles contribute towards premature death and illness (European Commission 2005). Physical activity (PA) is known to reduce the risks of a variety of serious diseases, improve mental health—see for example Biddle et al. (2000), Roberts et al. (2000), Dimeo et al. (2001), Pollock (2001), Batty (2002), Sari (2009), Teixeira et al. (2013)—and have a positive effect on sleep patterns (Brand et al. 2009; Foti et al. 2011).

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More recently, there has been considerable interest in reports of subjective well-being (SWB) as a measure of individual utility (Dolan and Kahneman 2008). Various relationships between reports of happiness and life satisfaction (LS) and the range of factors that could determine those reports—like income, health and social contact—have been explored (Dolan et al. 2008). Research into reports of LS has found a negative association between LS and obesity (Stutzer 2007; Oswald and Powdthavee 2007)—see also Katsaiti (2012) on a causal link running from obesity to reduced SWB.

In contrast, a positive association between LS and PA has been documented—see for example Rasciute and Downward (2010) and Kavetsos (2011) for a representative sample analysis in England and Europe, respectively, while Wang et al. (2012) establish a long-term association between physical activity and happiness in a Canadian sample. Lee and Park (2010) find a similar relationship in a Korean sample of disabled individuals. In the Netherlands, Stubbe et al. (2007) find a positive association between SWB and exercise participation in a study of twins, which are both mediated by genetic factors.

These studies have established a clear correlation between PA and SWB, but do not necessarily imply a causal path. It is true that clinical evidence shows that PA releases endorphins and serotonin in the brain which in turn are responsible for feelings of joy and satisfaction (Chaouloff 1997; Hoffmann 1997), thus offering an informal justification of the assumed direction of causality. But it is also true that happiness promotes health-related behaviours; happy people are less likely to smoke, drink, eat unhealthy and take drugs (Pettit et al. 2001). In line with the main theme of this paper, it has been argued, for example, that better mood is a strong determinant of participation in PA among women at moderate risk of breast cancer (Audrain et al. 2001).

More definitive causal paths are thus required, not only for the advancement of academic research but also for policy purposes, since establishing the aetiology of SWB will enable us to target resources at those things that have the greatest causal impact on SWB. Two relatively recent papers have recently provided an attempt towards this goal using happiness data. For the UK, Forrest and McHale (2009) control for the endogeneity of participation in PA using proximity to sports and fitness facilities as an instrumental variable (IV). They find that proximity is a significant determinant of PA for women, who are subsequently happier than their sedentary peers. A similar model has been applied in the US, suggesting that individuals are indeed more likely to be active in highly facility-endowed regions leading to higher reported levels of happiness, especially for males (Huang and Humphreys 2012). A limitation of both of these studies, which may drive some of the differences found, is selection effects; that is, some individuals may choose to locate in areas offering a greater number or variety of facilities.

Our study aims to contribute to the causal determination between PA (also referred to as 'exercise' here) and LS using a large European cross-sectional data set. An IV approach is applied using the respondent's perceived benefits of exercise participation—reported irrespective of whether the respondent exercises or not—as instruments. The results suggest that exercising increases LS for both genders and more so for males.

The following section describes the data and methodology in more detail. Section 3 presents the results of the analysis and discusses the validity of our instruments. Section 4 discusses the important implications our results have for policy—perhaps policymakers could promote exercise on the grounds that it improves SWB, as well as being of benefit for physical health (Cutler et al. 2003; Brunello et al. 2009).

2 Methods

The data come from the autumn wave of the 2004 Eurobarometer survey (62.0)—a public opinion survey carried out in European nations on behalf of the European Commission—asking approximately 1,000 individuals in each of 25 countries to report their LS on a 1–4 scale: "On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead?". This survey also includes a special section on exercise, asking individuals: "How often do you exercise or play sport? [three times a week or more; one-to-two times a week; one-to-three times a month; less often than that; never]".

In order to establish the relationship between exercise and LS, the following probit model is estimated:

$$LS_{i,s} = b_0 + b_1 EXERCISE_i + b_2 DEMO_i + b_3 D_s + e_{i,s}, \qquad (1)$$

where *LS* represents the binary LS variable for individual i at country s obtained by merging the relatively positive (*very/fairly*) and negative (*not very/not at all*) LS categories and assigning a value of 1 to the relatively positive and a value of 0 to the relatively negative categories; *EXERCISE* is a binary variable of participation equal to unity if individual i exercises on a regular basis, given by an affirmative response to the "three times a week or more", "one-to-two times a week", and "one-to-three times a month" frequency categories; *DEMO* is a vector of socio-demographic characteristics (gender, age, age squared, employment status, marital status, educational level, size of town of residence, and an indicator variable denoting the existence of at least one child under the age of 14); D_s are country dummy variables; and e represents the error term.

Note that as of 2004 the Eurobarometer ceased to report household income. Using the ISSP 2007 survey to measure the relationship between PA and SWB, it has been estimated that omitting the income variables in an ordered probit model inflates the remaining demographic coefficients by about 0.02 points (Kavetsos 2011). So we can be somewhat reassured that the omission of income here will not alter the magnitude or the interpretation of the estimated results to a significant extent.

Further note that Eq. (1) can be estimated using the entire 4-scale LS data, without a need for merging the relatively positive and negative categories, via an ordered probit or logit model. We, however, merge these categories and present results based on a probit model in order to make these comparable to the ones offered in the subsequent bivariate probit model.

As exercise participation might be an endogenous variable, estimation of Eq. (1) can only indicate a significant correlation between exercise and LS, without being able to determine a causal direction. For this, we need a suitable IV. This involves the introduction of a variable correlated with the engagement in exercise, but not with LS.

The survey asks all individuals, regardless of whether they are active or not: "In your opinion, what are the main benefits of sport?". Fourteen answers are offered: (1) to improve one's health (mentally/physically), (2) have fun, (3) relax, (4) be with friends, (5) make new acquaintances, (6) meet people from other cultures, (7) develop physical performance, (8) improve self-esteem, (9) develop new skills, (10) build character/identity, (11) achieve objectives, (12) stimulate the spirit of competition, (13) help disadvantaged people to integrate into society, and (14) other. These perceived benefits, or beliefs (Hamilton and White 2011), are arguably determining individual participation—the more benefits being revealed by the respondent, the higher the probability they will exercise (Brown 2005). The IV analysis here requires that these beliefs do not have a direct impact on LS. They are likely to impact upon LS indirectly through their effect on other determinants of LS, but are unlikely to affect LS directly—as borne out by our subsequent discussion on their suitability as IVs.

These beliefs can be gathered up into more general and generalisable descriptive codes, which potentially offer a better conceptualisation of the central phenomenon explaining the links between perceived benefits and exercise participation. For example, having fun, relaxing and being with friends could be one such generalisable category of 'pleasure'. An approach similar to Kan and Tsai (2004)—who regress individual BMI on dimensions of perceived risks of obesity obtained from a factor analysis—is applied here in order to decrease the dimensionality of the benefit measures by creating a smaller number of orthogonal indices (factors) that best describe the relationship between exercise participation and perceived benefits. See the "Appendix" for details.

As the endogenous variable is not continuous, we use a recursive bivariate probit model where the binary LS equation is:

$$LS_{i,s} = b_0 + b_1 EXERCISE_i + b_2 DEMO_i + b_3 D_s + w_{i,s}$$

and the exercise equation is given by:

$$EXERCISE_i = a_1 + \sum_k (\mu_k F_{k,i}) + a_2 DEMO_i + a_3 D_s + v_{i,s} \quad (2)$$

where k is the number of benefit factors, F, determined in the factor analysis; w and v are the error terms of the two equations, respectively, distributed as bivariate normal with zero mean and unit variance, with a correlation coefficient of $\rho = Cov(w, v)$ (Wooldridge 2002). Estimating this set of equations jointly yields more efficient estimates than a two-step procedure commonly used in IV models, since the latter does not consider the correlation of the error terms (Greene 1998). IV regressions based on recursive bivariate probit models have been used extensively in the related literature (e.g. Morris 2007), including cases with more than one instrument (Brown et al. 2005; Latif 2009) and if the set of benefit variables is a reliable instrument, then it must be (1) uncorrelated with the error term, i.e. $Cov(w, F_k) = 0$, and (2) partially correlated with $EXERCISE$ (French and Popovici 2011).

3 Results

3.1 Estimated Results

Table 1 presents summary statistics by frequency of exercise. The data are suggestive of poorer countries reporting lower exercise levels on average. Table 2 presents the results based of the probit estimation (Eq. 1), by gender. The socio-demographic determinants of LS are well-documented elsewhere (Dolan et al. 2008) and the results here are generally supportive of these findings. It is estimated that regular exercise enters positively and significantly in the LS equations, with a larger coefficient on men than women.

To address causality, Table 3 provides the results of the bivariate probit model (Eq. 2); panel A reports the estimates of the LS equation, panel B reports those of engagement in exercise. Three variables are used as instruments, which are essentially three dimensions derived from the factor analysis. These are: (1) 'health' (benefit one listed in the methods section); (2) 'pleasure' (benefits 2–5); and (3) 'purpose' (benefits 6–13 listed in the

Table 1 Exercise (%)

	3+ Times/week	1–2 Times/week	1–3 Times/month	Less often	Never
Austria	10.64	24.34	13.8	20.44	30.77
Belgium	17.89	23.85	8.37	12.66	37.24
Cyprus	28.17	11.67	3.22	6.44	50.5
Czech rep.	10.46	16.1	8.85	24.85	39.74
Denmark	28.63	32.39	10.14	13.06	15.78
Estonia	11.45	17.33	8.93	18.59	43.7
Finland	46.26	28.81	7.98	12.06	4.89
France	19.62	24.75	9.76	11.47	34.41
Germany	14.56	24.16	8.6	17.21	35.47
Greece	15.59	10.66	5.73	10.46	57.55
Hungary	6.73	9.15	4.21	14.2	65.72
Ireland	26.74	23.57	5.39	11.31	32.98
Italy	9.35	19.51	5.69	10.37	55.08
Latvia	11.88	12.42	7.6	14.56	53.53
Lithuania	13.72	11.28	6.7	18.62	49.68
Luxembourg	18.29	23.98	5.08	11.38	41.26
Malta	28.04	12.37	4.54	9.9	45.15
The Netherlands	16.43	34.17	7.46	9.98	31.96
Poland	15.38	15.18	7.07	14.55	47.82
Portugal	7.03	11.71	4.26	5.86	71.14
Slovakia	7.34	11.85	8.84	30.77	41.2
Slovenia	16.82	24.72	7.9	25.13	25.44
Spain	20.02	14.61	6.41	9.71	49.25
Sweden	39.1	33.47	9.15	11.56	6.73
United Kingdom	20.78	22.98	8.23	14.26	33.74
Total	18	20.16	7.59	14.85	39.4

Data are from the Eurobarometer 2004 autumn survey. Figures are percentages. 'Don't Know' answers are excluded from the calculations

Table 2 LS and exercise participation

	Male		Female	
		ME		ME
Exercise	0.315** (0.042)	0.07	0.253** (0.035)	0.064
Country effects	YES		YES	
Obs.	10,420		13,339	
Log-likelihood	−4,084.794		−5,849.129	

Regressions are probits. Dependent variable is the 2-scale LS. Robust standard errors, clustered at the country level, are reported in parentheses. ME are the Marginal Effects calculated for the case of binary independent variables

** $p < 0.01$

Table 3 LS bivariate probit results

	Male	ME	Female	ME
Panel A: LS equation				
Exercise	0.646** (0.182)	0.086	0.481** (0.148)	0.056
Panel B: Physical activity equation				
Health factor	0.257** (0.047)	0.088	0.362** (0.039)	0.115
Pleasure factor	0.329** (0.026)	0.113	0.348** (0.042)	0.111
Purpose factor	0.183** (0.051)	0.063	0.138** (0.052)	0.044
ρ	−0.205 (0.133)		−0.14 (0.081)	
Wald test ($\rho = 0$)	$\chi^2_{(1)} = 3.115$ ($Prob > \chi^2_{(1)} = 0.078$)		$\chi^2_{(1)} = 2.878$ ($Prob > \chi^2_{(1)} = 0.009$)	
Wald test ($IVs = 0$)	$\chi^2_{(3)} = 184.21$ ($Prob > \chi^2_{(3)} = 0.000$)		$\chi^2_{(3)} = 128.19$ ($Prob > \chi^2_{(3)} = 0.000$)	
Country effects	YES		YES	
Obs.	10,420		13,339	
Log-likelihood	−10,063.236		−13,191.577	

Regressions are bivariate probits. Panel A: Dependent variable is the 2-scale LS. Panel B: Dependent variable is the binary variable indicating whether the individual exercises regularly. Robust standard errors, clustered at the country level, reported in parentheses. ME are the Marginal Effects calculated for the case of binary independent variables

** $p < 0.01$

methods section above). This last category reflects beliefs about the meaning of sports and exercise participation to the individual (Ryff 1989; Seligman 2002; White and Dolan 2009) and its contribution to personal goals (Cantor and Sanderson 1999). Note that the 14th benefit, 'other', was discarded from the factor analysis as its Kaiser–Meyer–Olkin measure was less than 0.5—see more detailed discussion in the "Appendix".

The estimates provided in panel B suggest that participation in regular exercise is partially determined by all three factor scores; hence, partially confirming their reliability as instruments. Out of the three, the pleasure factor seems to be the most important determinant for regular participation for males. The results for females are similar, although the health factor appears to be the strongest determinant for regular exercise participation in this group.

The effect of regular exercise on LS is positive and significant for both males and females (panel A). The marginal effect for men is 0.086 and that of women is 0.056. A Wald test rejects the null hypothesis of zero correlation of the error terms in the LS and exercise equations, and suggests that the univariate probit model results reported in Table 2 underestimate the impact of exercise on LS for males and overestimates that for females.

3.2 Validity of IVs

The IV approach here would require these beliefs not to have a direct impact on LS. Nonetheless, certain perceptions and beliefs do have a direct effect. Perhaps, the most notable connection between beliefs and SWB is religion, with religious individuals being associated with higher reports of SWB (Dolan et al. 2008; Snoep 2008). The perceived benefits of exercise are, however, rather unlikely to be affecting SWB directly. For example, it is rather unlikely for perceived benefits of certain behaviours, such as volunteering or recycling, to have a direct impact on SWB other than increasing the probability of one actually engaging in that activity; that is, in the absence of volunteering/recycling, it is not obvious why holding a positive belief about such activities should impact SWB directly. Perceived benefits are not part of the beliefs determining individual identity (e.g. faith) or beliefs one holds for others or for society (e.g. trustworthiness). Arguably then, they only affect SWB indirectly through their influence on actually engaging in the activity.

A critical question that remains though is whether beliefs about the perceived benefits of exercise are somehow correlated with an unobserved variable—one's social or physical environment, say—which might also directly influence LS. So we need to consider in more detail how beliefs are formed and examine the degree to which some of the beliefs about the benefits of exercise are correlated with the 'immediate' environment that might also affect LS. Beliefs are usually formed via three psychological processes: (a) personal experiences, (b) social learning, and (c) the acquisition of knowledge (Anderson et al. 2004; Seymour et al. 2007). Our IV methodology will be valid only if none of these processes are correlated with LS.

We can assume that personal experiences can be strongly correlated with LS, as it will be strongly correlated with our environment, and of course past exercise participation is arguably both important for forming current beliefs about its benefits *and* LS today. Unfortunately, given the cross-sectional nature of the data we cannot observe past exercise behaviour. Social learning is only weakly correlated with LS, as a person may learn from others who do not inhabit her usual environment, and hence there is no reason to believe that activity of others impact on her LS directly. The acquisition of knowledge is not expected to be correlated with LS, as we would expect the syllabus of education, government policy, advertising, etc., to be homogeneous across individuals in the same country and our methodology controls for that via the inclusion of country fixed effects.

Therefore, the formation of beliefs from personal experience is the real challenge to our independence assumption. The fact that we are modelling beliefs for those who are not active might arguably mitigate some of this problem, especially as our sample is representative of these countries. We therefore consider those respondents stating that they do not exercise because they 'do not like' to. These individuals must have had either a negative experience with exercise/sport in the past or no experience at all—so their beliefs are not affected by a positive experience that might have boosted their LS too. As can be seen in Table 4, respondents in this subsample do not mention most of the benefits listed, but what the majority do mention is the 'health improvement' benefit. This implies that we can be quite confident that at least this belief—which in itself constitutes one of our IVs as well—is not correlated with personal experience or the immediate environment. Since this IV does prove the causality argument, we can arguably conclude that our key finding is unlikely to be confounded to any great extent by personal experience with exercise participation.

Table 4 Inactive respondents who "Do Not Like Sport"

	Mentioned (%)	Not mentioned (%)
Benefit		
Improve health (mentally or physically)	71.3	28.7
Have fun	25.3	74.7
Relax	31.3	68.7
Be with friends	22.1	77.9
Make new acquaintances	14.1	85.9
Meet people from other cultures	6	94
Develop physical performance	41.2	58.5
Improve self-esteem	16.8	83.2
Develop new skills	14.2	85.8
Build character/identity	12.6	87.4
Achieve objectives	15.7	84.3
Stimulate spirit of competition	15.4	84.6
Help disadvantaged people to integrate into society	8.9	91.1
Other	1	99

$N = 1{,}913$

4 Discussion

There is increasing interest in the relationship between physical activity and SWB, partly as a response to expanding waistlines and reductions in exercise. The existing evidence suggests, unsurprisingly, that physical activity and SWB are positively correlated. This appears to hold in a variety of country-specific data and for various subgroups of the population, although it is consistently stronger for males than for females. Establishing a causal relationship is a trickier challenge, and it has proved difficult to find an IV to allow the relationship *from* exercise *to* SWB to be robustly determined.

This study focuses on a cross-country European data set seeking to shed more light to the causal relationship from sports and exercise participation to LS using the perceived benefits of exercise (irrespective of whether individuals exercise or not) as instruments. The IV strategy indicates that all three benefit factors determined by a factor analysis— 'health', 'pleasure' and 'purpose'—are strong determinants of participation. This finding has important implications for policy in its own right. Attempting to boost exercise participation levels based solely on the health benefits appears to be incomplete. Our results here point to the fact that exercise is a pleasurable activity and should be promoted as such (Zimmerman 2009). Such a strategy is supported by evidence suggesting that individuals underestimate their enjoyment of exercising because they focus their attention on the unpleasant elements of physical activity, which are largely associated with the start of the workout (Ruby et al. 2011).

Consistently with previous research (e.g. Huang and Humphreys 2012), the impact of exercise on LS is greatest for men compared to women. This result might be stemming from lower female participation rates and the perceptions about what 'being sporty' means (Vilhjamsson and Kristjansdottir 2003). For example, there is evidence suggesting that female participation in physical activity and sports is not encouraged from school age

(Greendorfer 1977; Greendorfer and Lewko 1978), which probably explains why adolescent girls in Britain perceive sports activities as being more compatible with being male (Coakley and White 1992).

4.1 Methodological Contributions

The aim of this paper is to focus on one research question—the relationship between physical activity and SWB—and to try to disentangle any causal effects out of it, which adds to knowledge and potentially to more effective policy interventions designed to increase physical activity. To this extent, we believe the key evidence portrayed in the paper is related to *specific behaviours and actions* revealed by our two innovative methodologies: the IV approach and, what can be described as, *quantitative grounded theory analysis* of the categories of perceived benefits at a higher level of generality ('health', 'pleasure', and 'purpose'). We briefly discuss those two methodological contributions.

Given the importance of the IVs to determine causality, a substantive question remains about their validity as instruments. Perceptions/beliefs have generally been used, with varying degrees of success, as determinants of certain behaviours. Relatively recent examples include Peluchette et al. (2006) on the association between beliefs regarding workplace attire and workplace outcomes; Di Tella et al. (2007) who study materialistic and individualistic beliefs between squatters with and without legal land titles; Costa-Gomes and Weizsäcker (2008) in the context of an experimental study observing players' actions based on stated beliefs of the actions they expect their opponents to play; David (2008) in explaining variations in the risk premium of agents with heterogeneous beliefs about fundamental growth; and Di Tella et al. (2008) for the relationship between beliefs capturing anti-market sentiments and (perceived and actual) crime. In the health economics literature, recent examples include Poortinga (2006a) and Panter and Jones (2008) on the relations between the perceptions individuals hold of their local environment with obesity and physical activity.

To the best of our knowledge, perceptions have not been used as IVs before. This might raise some concern given that they are not 'ordinary' IVs, in the sense that they are not entirely exogenous to the individual per se. This would then imply a connection between LS and perceived benefits of exercise, with more satisfied individuals reporting a larger amount of benefits attributed to exercise and sports participation. The correlation between the four-scale LS and the total number of perceived benefits reported from individuals in our sample, however, is rather weak (about 0.11), supporting our hypothesis that beliefs affect LS indirectly through other channels rather than directly. This result is rather intuitive, since SWB is expected to be orthogonal to all sorts of perceptions (e.g. perceptions of benefits of volunteering, irrespective of whether the respondent volunteers or not), other than those trivially proven to be directly related to SWB (e.g. faith, relations with others, perceived financial and health states). We have further considered in more detail how beliefs are formed and examined the degree to which some of the beliefs about the benefits of exercise are correlated with the 'immediate' environment that might also affect LS, further supporting their validity.

This study also takes its focus on theory development by using *quantitative grounded theory*.[1] The grounded theory methodology in the social sciences (Bryant and Charmaz 2007; Thornberg and Charmaz 2012) involves the discovery of theory through the analysis of data, which operates in an inductive fashion. The first step is data collection through a

[1] We thank the reviewer for this point.

variety of methods, rather than beginning with a hypothesis: from the data/text the key points are marked with codes that are grouped into similar concepts that are further grouped into categories, which are the basis for the creation of a theory or a hypothesis.

In this respect, the reported causality in our model could reveal some important insights into the aetiology of physical activity through selective coding of 'narrative' reasons for exercise at a higher level of generality. The key 'narrative' was revealed in the factor analysis (see Table 7 in the appendix), which enabled us to create the higher order concepts—the factors—while the lower level key points are the response items to the benefits question. Thus, the core categories of 'health', 'pleasure' and 'purpose' were selected as grounded theoretic explanations for the causal link between physical activity and SWB.

4.2 Limitations and Future Research

Despite the added value of our research on the causal direction of the relationship between LS and exercise, our empirical approach is not free of limitations. First, we focus on exercise and sports participation, not a broad measure of physical activity that includes, for example, gardening. Second, our exercise variable is not a clear representation of the intensity, nor of the actual time spent doing the activity—see for example Hamer et al. (2009) and Hansen et al. (2001). Third, the dataset does not include measures of the respondent's health or health-related behaviours—such as smoking, excessive alcohol use, and unhealthy diets which have generally been shown to be negatively correlated with subjective well-being (Baum-Baicker 1985; Shahab and West 2011) and physical activity (Poortinga 2006b)—potentially leading to an overestimation of the exercise coefficient in the LS equation as this might be partly capturing the underlying positive association between exercise and health. Controlling for health is equally important for the participation equation. This might again potentially lead to an upward bias of the impact of exercise on LS.

Future research should focus on collecting primary data in order to firmly establish causality. This should involve conducting longitudinal studies that measure, and control for, the three types of belief formation processes (measuring the frequency, duration and valence of personal experiences with physical activity, observations of others' experiences and outcomes, and semantic knowledge about activity benefits). Future research could also make more use of field experiments, which will provide the conclusive test of the causal role of activity on LS (Charness and Gneezy 2009).

Notwithstanding these issues, this study offers some evidence where policy can step into boost exercise participation rates by promoting it as a fun, pleasurable, activity. Happiness is part of the feedback individuals derive from exercising, which can be viewed as an important mechanism encouraging further engagement in that behaviour, and which we are now able to measure quite successfully (Dolan and Metcalfe 2012).

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Appendix

This section presents the results of the factor analysis carried out for the perceived benefit indicators included in the survey. The methods carried out here are well documented in textbooks and handbooks—see for example Manly (2005) and Nardo et al. (2008). In brief, we first perform a factor analysis where the suggested number of factors is identified based on the Kaiser criterion, which drops factors with eigenvalues below unity. Second, the Kaiser–Meyer–Olkin (KMO) measure for sampling adequacy is calculated; both for individual variables and for the overall analysis. KMO values vary between zero and one, where values equal to 0.6 or above are desirable, since large values imply that a certain variable has enough information in common to produce a reliable factor analysis. Third, in order to obtain an interpretable pattern of factor loadings a varimax rotation is usually performed. Finally, factor scores are estimated.

The factor analysis here is based on tetrachoric correlations of the underlying variables (i.e. perceived benefits). An initial factor analysis on all 14 variables suggests that three factors are enough to summarize these benefit measures. These are the factors with a loading greater or equal to 1 (Kaiser criterion). However, subsequent estimation of the KMO measure of sampling adequacy suggests that the last variable, "other" ($KMO_{Other} = 0.492$) should be discarded from the analysis since any value below 0.5 is considered to be unacceptable. This also makes intuitive sense given the unspecific nature of this variable. Repeating the factor analysis on the remaining 13 variables indicates that the benefit indicators can be summarized by two factors, as reported in Table 5. Furthermore, we now obtain KMOs well above 0.75 and an overall KMO of 0.929—see Table 6.

Going back to Table 5, we observe that the third factor has an eigenvalue of 0.956 and does not fulfil the Kaiser criterion at the margin. Deriving the rotated factor loadings under the strictly suggested two factor model however does not yield a clear distinction of benefit factors, since under that specification the health benefit would be included together with the 'purposeful' benefits (e.g. 'develop new skills') leading to a mixed interpretation of the factors. Thus, we will allow for three factors to be extracted from the model. The varimax rotated factor loadings are reported in Table 7. Bold figures indicate the benefits with the highest loading across the three factors.

Hence, benefit 1 can be summarised in Factor 1, benefits 2–5 in Factor 2 and benefits 6–13 in Factor 3. We label these factors 'health', 'pleasure' and 'purpose', respectively. The last column labelled 'uniqueness' indicates the proportion of the common variance of each benefit indicator not well-represented by the three factors, where lower values are desirable.

Table 5 Factor analysis and eigenvalues

	Eigenvalues
Factor 1	5.562
Factor 2	1.31
Factor 3	0.956
Factor 4	0.786
Factor 5	0.754
Factor 6	0.618
Factor 7	0.551
Factor 8	0.493
Factor 9	0.468
Factor 10	0.426
Factor 11	0.401
Factor 12	0.382
Factor 13	0.292

23,759 Observations. Retained factors = 3

Table 6 KMO measures

Perceived benefit	
Improve health (mentally or physically)	0.759
Have fun	0.891
Relax	0.94
Be with friends	0.904
Make new acquaintances	0.927
Meet people from other cultures	0.914
Develop physical performance	0.925
Improve self-esteem	0.944
Develop new skills	0.949
Build character/identity	0.941
Achieve objectives	0.941
Stimulate spirit of competition	0.937
Help disadvantaged people to integrate into society	0.934
Overall	0.929

Table 7 Rotated factor loadings

Perceived benefit	Factor 3: purpose	Factor 2: pleasure	Factor 1: health	Uniqueness
1. Improve health (mentally or physically)	0.115	−0.0357	**0.869**	0.231
2. Have fun	0.23	**0.671**	−0.272	0.423
3. Relax	−0.037	**0.679**	0.294	0.452
4. Be with friends	0.302	**0.658**	−0.218	0.429
5. Make new acquaintances	0.436	**0.655**	0.01	0.382
6. Meet people from other cultures	**0.587**	0.562	0.113	0.327
7. Develop physical performance	**0.704**	−0.146	0.049	0.481
8. Improve self-esteem	**0.589**	0.326	0.244	0.487
9. Develop new skills	**0.684**	0.395	0.075	0.371
10. Build character/identity	**0.683**	0.301	0.217	0.396
11. Achieve objectives	**0.751**	0.183	−0.014	0.402
12. Stimulate spirit of competition	**0.749**	0.238	−0.056	0.379
13. Help disadvantaged people to integrate into society	**0.62**	0.405	0.198	0.412

Bold figures indicate benefit indicators with the highest factor loadings across factors

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