The relationship between intensity and duration of physical activity and subjective well-being

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Aim: Previous research documented a positive effect of physical activity on subjective well-being (SWB). Yet, mainly broad activity measures (e.g. resulting from yes–no questions) were used and the effect of different participation intensities and durations has been largely neglected. The aim of this study is to examine the effect of physical activity on SWB by focusing on participation intensity and duration. Methods: Survey data from 28 European countries are used for the analysis (n = 22 971). Two regression models (Generalized Method of Moments) are estimated which analyze the effect of participation intensity and duration on SWB (measured by life satisfaction). Given the endogeneity of the participation measures, instrumental variables are used (sport opportunities, club membership, time spent sitting). The models also control for other factors that could affect SWB (e.g. age, occupation). Results: The results for participation intensity show that the number of days people practised at moderate intensity in the week prior to the interview have a significant and positive effect on SWB, while the number of days with vigorous-intensity activity has a significant and negative impact. Similarly, the models for duration indicate that the minutes spent on moderate-intensity activity significantly add to SWB, while the minutes spent on vigorous-intensity activity significantly reduce the level of SWB. Conclusions: The findings challenge the World Health Organization’s recommendation in the sense that activity at moderate and vigorous intensity is not interchangeable if the aim is to also improve SWB (and not only physical health).

Introduction

The positive relationship between physical activity and various physical health parameters has been widely documented in previous research.¹⁻³ For example, physical activity was found to reduce the incidence of high blood pressure, diabetes, heart disease, asthma and arthritis.¹ Given these positive health effects public health policies across countries recommended and promoted participation in sport and physical activity. For example, in the UK, the Game Plan⁵ stated that the ‘primary aim is to develop a sport and physical activity culture to produce a fitter, more active population and realize the significant health benefits and savings available’ (p. 90). The German Parliament acknowledged that regular participation in physical activity would represent an important source for both physical and psychological health, and therefore, launched several campaigns to promote and foster participation in sport and physical activity.⁶ Yet, the effectiveness of public health and participation campaigns may depend on the perceived barriers which prevented

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inactive people from participation so far. ‘Lack of knowledge’ was identified as one barrier implying that people do not know how many minutes they should practise and at what intensity. The World Health Organization (WHO) provided some advice in this regard: adults aged 18–64 should do at least 150 min of physical activity at moderate intensity or 75 min at vigorous intensity throughout the week to achieve the desired health outcomes. In doing so, activity sessions should last at least 10 min. According to the above recommendation it seems that the two types of intensity (moderate vs. vigorous) could be considered as being interchangeable; people could practise at either intensity while adjusting the number of minutes (i.e. more minutes are recommended for moderate-intensity activity). Although these recommendations were mainly designed based on ‘physical’ health outcomes, the effect of different participation intensities and durations on subjective well-being (SWB) remains unclear.

Following Diener et al., SWB can be defined as ‘a person’s cognitive and affective evaluations of his or her life’ (p. 63). It is recognized that SWB is connected more to psychological than to physical health, specifically it is associated with higher levels of life satisfaction and happiness. This may be one reason why the terms SWB, happiness, and life satisfaction were sometimes used interchangeably in the literature although it has to be noted that there are many measures available which can lead to different results. Importantly, SWB is also distinct from psychological health which is often linked to physical health. Most studies examining the impact of physical activity on SWB reported a positive effect. However, in many studies only broad measures of physical activity were used (e.g. yes–no questions); only a few studies using more detailed activity measures have been published so far. For example, Downward and Rasicu investigated the role of participation duration and frequency. They found that the number of times and total minutes of participation had a significant positive effect on SWB. Also examining the effect of duration and frequency, Wicker et al. documented that a 30 min fitness program conducted twice a week over a 4-week period significantly improved SWB. Downward and Dawson reported that the total minutes of sport participation positively affect happiness. Also, the total minutes of sport participation at moderate intensity and participation at moderate intensity of three or more times a week had a significant positive effect on happiness.

To conclude, a few studies exist which used measures for participation frequency and duration, while the effect of participation intensity has been largely neglected with one exception. However, the effect of vigorous-intensity activity which is also included in physical activity recommendations has not yet been examined. Also, previous studies examined only data from one country supporting the need for more cross-country investigations. It is necessary to document how long and, particularly, at what intensity people should practise to achieve significant improvements in SWB. This is important for analyzing how general physical activity recommendations are associated with SWB.

The purpose of this study is to shed further light on the relationship between the duration (i.e. minutes per week) and intensity (moderate vs. vigorous) of physical activity and SWB. Specifically, we advance the following main research question: How does participation intensity and duration affect SWB? Importantly, we control for other factors which can also influence SWB. For our examination, we use survey data from the Eurobarometer 80.2 including 28 European countries. The results show that the more days and the more minutes people practise at moderate intensity, the higher the level of SWB. For vigorous-intensity activity a significant negative effect on SWB was observed—for both participation intensity and duration. Our findings have implications for public health in the sense that physical activity recommendations (e.g. from the WHO) suggesting vigorous-intensity activity have to be treated with caution given its negative effect on SWB.

**Methods**

**Data source**

The present analysis is based on survey data from the Eurobarometer 80.2 including respondents from all 28 countries of the European Union. The Eurobarometer is authorized by the European Commission. Each wave has a different focus; this wave contains specific questions on climate change, agricultural policy, patient safety, and sport and physical activity; demographics are assessed in every wave. Country-specific samples were collected from 23 November to 2 December 2013 by TNS Emnid using a multi-stage, random (probability) sampling. A random selection of sampling points ensures that urban and rural areas are adequately represented in the sample; afterwards respondents are chosen randomly or using quota sampling. In large countries, approximately 1000 respondents are interviewed; for smaller countries (e.g. Luxembourg, Malta, Northern Ireland) the sample size is approximately 500. The country-specific samples are representative and lead to an overall sample of n = 27,919. During the data cleaning, respondents with missing values on relevant questions were excluded leaving 22,971 cases for the analysis.

**Measures and variables**

An overview of the variables used in this study is presented in table 1. In the questionnaire, an individual’s level of SWB was assessed with the following question: ‘On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead?’ Similar to previous research, SWB was measured on a four-point scale. Participation intensity is captured with two variables reflecting the number of days people were physically active at moderate and vigorous intensity, respectively, in the week prior to the interview. Duration of physical activity at moderate or vigorous intensity is measured with two variables where each category covers duration intervals of 30 min. The sociodemographic characteristics were measured with a set of variables including age, gender, volunteering in sport, difficulty paying bills, self-assessed social class, marital status, and occupation. The description of these variables including their codes can be retrieved from table 1.

**Empirical analysis**

Two regression models are estimated to investigate the effect of participation intensity and duration on SWB. Because the two activity variables are interrelated because, for example, it is unlikely that individuals respond ‘0 days’ to the intensity question while reporting several minutes of moderate- or vigorous-intensity activity, separate estimates are provided to avoid multicollinearity issues. Model 1 includes the two intensity variables (Int_moderate, Int_vigorous), while Model 2 includes the two duration variables (Dur_moderate, Dur_vigorous). Adding squared terms of the participation variables to the models yields insignificant coefficients only; these terms are therefore excluded. The socio-demographic variables are entered as control variables because previous research showed that SWB is determined by a variety of other factors including age, gender, marital status, occupation, voluntary work etc. The results of the correlation analyses of the
socio-demographic controls indicated that multicollinearity should not be a concern in our models. Moreover, country dummies are included and standard errors are clustered by country to control for country-specific differences.

The choice of the estimator needs some discussion. When examining the effect of physical activity on SWB, endogeneity may be a concern because there are other factors (e.g., physical health) that may be correlated with both the SWB variable and the participation measures. Moreover, the simultaneity of participation and well-being measures must be accounted for when trying to make causal inferences, i.e., SWB may also affect participation. In previous research, several studies addressed these issues by using instrumental variables. Downward and Dawson provide an excellent discussion of the instruments used in previous research. For example, studies have used some measure of sport supply, the frequency of attending sport events and membership in a sport club, or the perceived benefits of sport by individuals. In this study, we use three instruments. Similar to previous research, we use a measure of sport supply (i.e. the perceived availability of sport opportunities) and whether individuals are a member of a sport club. The third instrument is the time spent sitting on a usual day. All instruments are correlated with the physical activity variables, but not with SWB. The first stage regression estimates indicate that the instruments are valid; the null hypothesis that the instruments do not affect the participation measures can be rejected ($p < 0.001$; all $F$-values $> 62$). In line with previous research, we use the Generalized Method of Moments (GMM) estimator. It is considered more appropriate than the two-stage least squares (2SLS) estimator for large scale cross-sectional data where heteroskedasticity is likely. The GMM estimator produces heteroskedasticity consistent standard errors.

### Results

The summary statistics are displayed in table 2. They show that 54.2% of the respondents are female. On average, respondents are 50.1 years old. Altogether, 24.2% are a member of a sport club and 8.5% are engaged in voluntary work in sport. Approximately half of the respondents are married (53.4%), do never/almost never have any difficulty paying their bills (59.8%), consider themselves a member of the middle class in society (51.1%), and are currently not working including being unemployed, retired, a student or a housewife (49.1%). Most of the employed people are white-collar (19.7%) or blue-collar workers (13.2%). The average level of SWB is 2.99 which is equivalent to ‘fairly satisfied’. On average, respondents reported that they practised 2.17 days at moderate intensity and 1.46 days at vigorous intensity in the week prior to the interview. Average participation duration was 1.65 (moderate intensity) and 1.51 (vigorous intensity), respectively, which is equivalent to $\sim 30$ min per week (table 2).

The results of the instrumental variable regression models are summarized in table 3. Because the focus of this research is on the effect of participation intensity and duration on SWB, the presentation of results concentrates on these variables. Model 1 examines the relationship between participation intensity and SWB. The results show that the number of days people were physically active at moderate intensity significantly add to SWB, while the number of days spent sitting on a usual day. All instruments are correlated with the physical activity variables, but not with SWB. The first stage regression estimates indicate that the instruments are valid; the null hypothesis that the instruments do not affect the participation measures can be rejected ($p < 0.001$; all $F$-values $> 62$). In line with previous research, we use the Generalized Method of Moments (GMM) estimator. It is considered more appropriate than the two-stage least squares (2SLS) estimator for large scale cross-sectional data where heteroskedasticity is likely. The GMM estimator produces heteroskedasticity consistent standard errors.

### Tables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>Life satisfaction (1 = not at all satisfied; 4 = very satisfied)</td>
</tr>
<tr>
<td>Int_moderate</td>
<td>Number of days last week with moderate-intensity activity</td>
</tr>
<tr>
<td>Int_vigorous</td>
<td>Number of days last week with vigorous-intensity activity</td>
</tr>
<tr>
<td>Dur_moderate</td>
<td>Minutes spent on moderate-intensity activity last week (0 = 0, 1 = &lt; 30, 2 = 31–60, 3 = 61–90, 4 = 91–120, 5 = &gt;120)</td>
</tr>
<tr>
<td>Dur_vigorous</td>
<td>Minutes spent on vigorous-intensity activity last week (0 = 0, 1 = &lt; 30, 2 = 31–60, 3 = 61–90, 4 = 91–120, 5 = &gt;120)</td>
</tr>
<tr>
<td>Sport_opportunities</td>
<td>The area where you live offers you many opportunities to be physically active (1 = totally agree, 4 = totally disagree)</td>
</tr>
<tr>
<td>Club_member</td>
<td>Membership in sport club (1 = yes)</td>
</tr>
<tr>
<td>Time_sitting</td>
<td>Time spent sitting on a usual day (1 h or less; 10 = &gt;8.30 h)</td>
</tr>
<tr>
<td>Age</td>
<td>Age (in years)</td>
</tr>
<tr>
<td>Age2</td>
<td>Age squared</td>
</tr>
<tr>
<td>Female</td>
<td>Female gender (1 = yes)</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Voluntary work in sport (1 = yes)</td>
</tr>
<tr>
<td>Difficulty_paying</td>
<td>Difficulty paying bills last year (1 = mostly of the time, 2 = from time to time, 3 = almost never/never)</td>
</tr>
<tr>
<td>Social_class</td>
<td>Self-assessment of social class (1 = working class, 2 = middle class, 3 = upper class)</td>
</tr>
<tr>
<td>Marital_status</td>
<td>Marital status (single with partner, single, divorced, widowed, married)</td>
</tr>
<tr>
<td>Occupation</td>
<td>Occupation (small owner, large owner, employed professional, self-employed professional, middle management, white-collar worker, blue-collar worker, farmer, not working/unemployed/retired/student/housewife)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>2.99</td>
<td>0.77</td>
</tr>
<tr>
<td>Int_moderate</td>
<td>2.17</td>
<td>2.44</td>
</tr>
<tr>
<td>Int_vigorous</td>
<td>1.46</td>
<td>2.06</td>
</tr>
<tr>
<td>Dur_moderate</td>
<td>1.65</td>
<td>1.53</td>
</tr>
<tr>
<td>Dur_vigorous</td>
<td>1.51</td>
<td>1.59</td>
</tr>
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<td>Sport_opportunities</td>
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<td>0.92</td>
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<tr>
<td>Club_member</td>
<td>0.242</td>
<td>—</td>
</tr>
<tr>
<td>Time_sitting</td>
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<td>2.49</td>
</tr>
<tr>
<td>Age</td>
<td>50.16</td>
<td>17.12</td>
</tr>
<tr>
<td>Female</td>
<td>0.542</td>
<td>—</td>
</tr>
<tr>
<td>Volunteer</td>
<td>0.085</td>
<td>—</td>
</tr>
<tr>
<td>Difficulty_paying Mostly</td>
<td>0.125</td>
<td>—</td>
</tr>
<tr>
<td>Difficulty_paying Sometimes</td>
<td>0.277</td>
<td>—</td>
</tr>
<tr>
<td>Social_class Working</td>
<td>0.462</td>
<td>—</td>
</tr>
</tbody>
</table>

The coefficients indicate that the magnitude of...
the effects varies between the two types of participation intensity; the effect for moderate intensity is larger than for vigorous intensity.

Model 2 includes the duration of physical activity variables, i.e. how many minutes people have practised in the week prior to the interview. The results reveal that the more minutes individuals have practised at moderate intensity in the week prior to the interview, the higher the reported level of SWB. On the contrary, the minutes spent on physical activity at vigorous intensity significantly reduces the level of SWB. Similar to Model 1, the positive effect of moderate intensity is larger than the negative effect of vigorous intensity. The correlation of the error terms of the two models indicates a moderate correlation ($r = 0.526; p < 0.001$).

### Discussion

#### Discussion of results and implications

The effects of the socio-demographic control variables on SWB are in line with previous studies showing, for example, that middle-aged people are less happy than younger and older people, married people are happier than their non-married counterparts, and employed people are happier than people who are not working for various reasons.10,12,23

In line with previous research,11,17–22 the regression models supported the positive relationship between physical activity and SWB—but only for moderate-intensity activity. The contribution of this study lies in the detailed examination of the above mentioned positive effect of participation in physical activity by specifically looking at participation intensity and duration. Here, the findings show that the number of days people participate in moderate-intensity activity is positively associated with SWB—as well as the duration of moderate-intensity activity. This positive effect is similar to the studies by Downward and Rasciute11 as well as Downward and Dawson18—yet, they did not distinguish between different types of participation intensity. Our findings also support the view of Fox28 stating that regular physical activity at moderate intensity is a viable way of improving SWB in the general public. Attention needs to be paid to the relationship between vigorous-intensity activity and SWB; the negative effect in both models indicates that an increase in the number of days and minutes of physical activity at vigorous intensity is associated with significant decreases in SWB.

This study has implications for public health policies since it gives some advice regarding the intensity and duration that should be chosen to achieve high levels of SWB. When the aim is to improve SWB among the population (in addition to physical health), it can be recommended that people are physically active at moderate intensity—the more days and the more minutes individuals practise at this intensity, the higher the level of SWB. Yet, the WHO’s recommendation8 of at least 75 min of vigorous-intensity physical activity throughout the week may be effective for physical health, but not for SWB according to the results of this research. Given the opposite effects on SWB, the two types of participation intensities should not be considered as being interchangeable. When the aim is to improve both physical health and SWB, it can be recommended to focus on moderate-intensity activity where the number of both days and minutes were found to add to SWB. This is an important point because other studies also recommend vigorous-intensity activity,29 but without being aware of its negative effect on SWB. According to the results of this research, participation in vigorous-intensity activity cannot be recommended from the viewpoint of increasing SWB.

Moreover, this study has policy implications. Policy makers should promote physically active behaviour of the population by providing infrastructure such as parks that were found to facilitate physical activity. For example, residents’ perceptions of neighbourhood park quality were positively associated with moderate-to-vigorous physical activity and negatively with Body-Mass-Index (BMI).30 Specifically, the type of activity area within parks was found to be relevant to the intensity of adult activity.31

### Conclusions

This study examined the effect of participation intensity and duration on SWB using representative survey data from 28 European countries. The findings support the need of having more detailed participation measures rather than only variables capturing whether people participate in sport or physical activity or not. The regression results show that moderate-intensity and vigorous-intensity activity have opposite effects on SWB; the former positively affects SWB, while the latter has a negative impact. This study adds to the body of research on the determinants of SWB and on the relationship between physical activity and SWB, respectively. It contributes to the literature by providing information about the effect of participation intensity and duration—aspects of physical activity that have been largely neglected in many previous studies.

The present study has some limitations which represent directions for future research. First, the study is limited to the available data and variables. The data are cross-sectional in nature. In future research, it would be interesting to examine the relationship between different participation intensities and durations over time. The dependent variable ‘satisfaction’ was only measured on a four-point scale which is associated with a rather low level of variation. More detailed SWB measures would be helpful to also examine nuances of changes in SWB as a result of changes in participation intensity and duration. Second, the classification into moderate and vigorous activity was performed by the survey respondents meaning that it results from subjective assessment. This means that the same activity may be considered moderate by some people, while others may consider it vigorous. Although this does not affect the findings of the present study because the intensity of physical activity is...
always subjective, it would be interesting to add some objective measures of participation intensity (e.g. heart rate) in future studies.

Conflicts of interest: None declared.

Key points
- This study examines the effect of participation in physical activity on SWB with a particular focus on participation intensity and duration.
- Contrary to previous research more detailed participation measures are used.
- The results show that the number of days and minutes individuals practised at moderate intensity significantly add to SWB.
- Vigorous-intensity activity significantly reduces SWB.
- Physical activity recommendations (e.g. from the World Health Organization) which treat moderate- and vigorous-intensity activity as being interchangeable should be reconsidered if the aim is to also improve SWB.

References
25. GESIS. ZAS877: Eurobarometer 80.2 (2013), 2014. Available at: https://dbk.gesis.org/dbks/search/SDESC2.asp?no=5877&amp;amp;amp;search=Eurobarometer&amp;amp;amp;search2=1&amp;amp;amp;DB=E (16 January 2015, date last accessed).