Toepoel, Vera, Annemieke Luiten, and Robbert Zandvliet. 2021. "Response, Willingness, and Data Donation in a Study on Accelerometer Possession in the General Population." *Survey Practice* 14 (1). https://doi.org/10.29115/SP-2021-0005.

ARTICLES

# Response, Willingness, and Data Donation in a Study on Accelerometer Possession in the General Population

Vera Toepoel[1], Annemieke Luiten[2], Robbert Zandvliet[3]

[1] Utrecht University, [2] Innovation, Statistics Netherlands, [3] I&O Research

Keywords: data donation, accelerometers, health, physical activity, activity trackers

https://doi.org/10.29115/SP-2021-0005

Survey Practice

Vol. 14, Issue 1, 2021

In this study, we investigate prevalence of smartwatches; activity trackers (e.g., Fitbits); and apps to track personal activity on smartphones in the Dutch general population. In addition, we ask for respondents' willingness to participate in a follow-up accelerometer study and wear a professional loaned activity tracker for a week. About half of the sample owns a personal device to track physical activity; 58.0% of those respondents are willing to copy personal data from the device into a questionnaire; 40.6% are willing to upload a spreadsheet from their personal device to a research portal. About half of the respondents of the entire sample express willingness to participate in a follow-up study and wear a professional accelerometer for a week. However, once invited, only 60.0% actually consent to participation. Respondents who own a personal device to monitor physical activity are more inclined to participate in the follow-up accelerometer study than respondents who do not own a personal device. This study shows that respondents with personal activity trackers show higher levels of physical activity compared to respondents without a personal device. In addition, participants in the follow-up study show higher levels of physical activity. Hence, estimating physical activity from personal activity trackers or professional activity trackers will likely result in biased results. We do not find significant differences between respondents with a personal device versus respondents without—nor people who participate in the accelerometer follow-up study—in sitting, standing, and lying time, however. Estimating sedentary behavior from personal or professional activity trackers is likely to result in unbiased results.

## 1. Introduction

Institutes such as public health offices, statistical offices, ministries, and municipalities measure their population's level of physical activity (PA) and sedentary behavior to investigate public health and develop policy accordingly. PA is defined as any bodily movement produced by the skeletal muscle that results in energy expenditure (Prince et al. 2008). Traditionally, research of PA is based on survey data. However, survey data are known to suffer from errors related to representativeness and measurement error (Ferrari, Friedenreich, and Matthews 2007; Fruin and Rankin 2004; Helmerhorst et al. 2012; Sallis and Saelens 2000; Shephard 2003; Welk et al. 2007; Wijndaele et al. 2015). Response rates for surveys are typically low and are declining over the past couple of decades (Luiten, Hox, and de Leeuw 2020). Response rates for objective measures such as accelerometer data are probably not going to be better due to high respondent burden. In addition, PA in surveys is often overestimated due to socially desirable responding (Adams et al. 2005; Helmerhorst et al. 2012; Prince et al. 2008; Warnecke et al. 1997; Welk et al. 2007).

In addition to surveys, PA can also be measured with accelerometer data generated by activity trackers (Ward et al. 2005). Activity trackers measure PA objectively by, for instance, counting steps, heart rate, etc. Accelerometer approximations can be applied to general daily activities by calculating the metabolic equivalent of tasks (METs value). The MET value is calculated by dividing the oxygen uptake by the mass of a person in kilogram times 3.5 (Mortazavi et al. 2013). Some people have their own activity trackers (e.g., Fitbit or smartwatches). The quality, algorithms, and type of parameters available differ per device. There are also high quality activity trackers where one can get the raw data. These activity trackers can be expensive. For research purposes, these trackers have to be lent out and sent back by respondents. In general, it is relatively unclear to what extent respondents are willing to wear activity trackers for research purposes or to what extent activity trackers can replace surveys from a data quality perspective. Furthermore, it is unclear to what extent the data of personal activity trackers could be useful in measuring PA.

In this paper, we use the probability-based I&O Research Panel to investigate to what extent the Dutch general population is in possession of personal activity trackers and monitors PA on a daily basis. We compare PA of people with and without personal trackers to find out if there are differences in their PA. In addition, we investigate the willingness to wear a professional high quality tracker (ActivPAL) for a week. In addition to these panel results, we present results from a follow-up study of panel members who actually wore the ActivPAL for a week.

This study should enable researchers to make more considered choices regarding methods for studies on PA as well as the use of sensor data for research purposes.

## 2. Methods

The survey was conducted in the I&O Research Panel. This is a probability-based online panel of people in the Netherlands. Internet penetration in the Netherlands is about 98% (Central Bureau of Statistics 2018). The general questionnaire consisted of a questionnaire on PA (in Dutch) and was administered June 2-8, 2020. See Appendix A for the full questionnaire. We randomly divided respondents into two versions of a health survey: the SQUASH questionnaire and I&O's own survey on PA.[1]

1 We randomly divided respondents to two versions of a health survey to investigate comparability of the two surveys. Results are not shown here. Type of health survey did not affect willingness to share data. Also, the type of health survey did not affect willingness to participate in the follow-up study for respondents with their own devices. We found a significant difference of the type of health survey on willingness to participate in the follow-up study for respondents without own devices (45.1 % in version A vs. 39.3% in version B, $Chi^2_{(1,1157)} = 3.95$, p=.05).

In addition, we asked questions about possession of activity trackers (smartwatch and activity tracker, such as Fitbit or app on phone); questions about willingness to share data of one's own device by copying daily information in the survey or by uploading a data file to a research portal; questions about the willingness to wear a professional loaned device and questions about conditions under which people would be willing to participate in research wearing a professional loaned device. A total of 5,000 I&O panel members were invited to complete 'a questionnaire on physical activity'; 2,276 panel members completed the survey (see Appendix B for descriptives of the gross and net sample for gender, age, and education). In a follow-up on the survey, 80 respondents who indicated their willingness to wear a professional device were invited to wear an ActivPAL accelerometer, which is worn on the thigh. We chose a sample of 80 due to availability of the ActivPAL accelerometers. The follow-up study served as a pilot for investigating feasibility and logistics of lending a professional device to measure physical activity. The follow-up study was fielded from June 22 to July 12, 2020. Selection for the follow-up study was based on respondent's possession of a personal device. Half of the sample (40) were in possession of a personal device to measure PA, the other half (40) did not own a personal device to monitor PA. In addition, we made sure we had a heterogenous sample based on gender, age, and education. Consenting respondents in the follow-up study were sent the accelerometer plus instructions on how to position the device on the body. Respondents were asked to wear the accelerometer for one week and send the accelerometer back afterwards. An incentive of 20 euros was used in the follow-up study. (Respondents in the general survey received an incentive through the standard point system used by the panel.) No reminders were sent. In the follow-up study, we compare ActivPAL measures of respondents who own a personal device to monitor PA and respondents who do not own a device. Respondents' adherence to the Dutch activity guidelines in terms of minutes per week moderate and vigorous activity, number of days of bone and muscle strengthening activity, and number of days of balance inducing activity were calculated and compared.

## 3. Results

### *3.1 Participation rates*

As shown in Table 1, 49.2% of the respondents in the survey use a smartwatch, an activity tracker (e.g., Fitbit), or an app on their phone to measure PA. A total of 58.0% of the respondents who use such a device are willing to copy personal PA data in a questionnaire while 40.6% of activity tracker users are willing to upload their data to a research portal. In total, 48.7% of the respondents are willing to wear a loaned accelerometer for a week.

From the respondents who indicated their willingness to wear a loaned device for a week (n=1,109), 80 respondents were invited to participate in the follow-up study to wear the loaned accelerometer for a week. Once we approached them and requested their actual participation in the follow-up study, 48 (60%

**Table 1.** Activity tracker possession, willingness to share data from own tracker, and willingness to wear a professional loaned tracker.

| | N | % | |
|---|---|---|---|
| Invited | 5000 | | |
| Respondents | 2.276 | 45.5 | of sample |
| Owns smartwatch/Fitbit/app on phone | 1.119 | 49.2 | of respondents |
| Willing to copy own data in questionnaire | 509 | 58.0 | of owners[1] |
| Willing to upload data | 332 | 40.6 | of owners[2] |
| Willing to wear loaned accelerometer | 1.109 | 48.7 | of respondents |

[1]Owners who always/sometimes use their device to monitor their PA (base=878)

[2]Respondents who indicated they would never share these data (Q7) skipped this question (base=817)

of the 80 invited) were willing to actually participate in the follow-up study and wear the loaned accelerometer. In the end, 45 (56.3%) of the 80 invited respondents actually wore the accelerometer for at least 4 days.

### *3.2 Reasons to reconsider participation*

Respondents noted multiple reasons to reconsider participation in the follow-up study. The saliency of the research topic is most prevalent; 159 respondents (29.1%) would reconsider participation if they were totally convinced of the purpose of the study. In addition, 134 respondents (24.5%) would reconsider participation if they were convinced the study to be totally anonymous. Other reasons were if given a higher incentive (n=69; 12.6%, minimal amount mentioned is 40 euro), if given advice on physical activity (n=68; 12.5%), if given feedback on physical activity (n=51; 9.3%), if they would move like they normally do (n=29; 5.3%)[2], if they were younger, slimmer, or not ill (n=27; 4.9%), and various other reasons (n=145; 19.8% of all answers given[3]), ranging from 'if it doesn't give me a skin rash' to 'if I can combine it with work', to 'I already move enough' to 'I can't be bothered.'

### *3.3 Willingness to wear the accelerometer*

Respondents who own a smartwatch or activity tracker such as Fitbit were more willing to wear the accelerometer than respondents who use their phone or do not monitor their PA (61.8%, 50.4%, and 42.3%, respectively; means differ significantly according to LSD post-hoc tests, $F(2,2275) = 27.4\ p < .001$).[4]

2 The survey was held in June 2020, during the Covid-19 pandemic. Many people worked from home and could not participate in physical activities.

3 This "other" category was an open question, and respondents could mention more than one reason. Therefore, we give a percentage on the total number of answers.

4 Analyses showed that having a smartwatch or having another kind of dedicated activity tracker was highly similarly related to the phenomena under study. In the remainder of this article, the data for these two devices are pooled.

**Table 2.** Willingness of respondents with own device to copy or upload their data.

| % | Copy device results into questionnaire | n | Upload data to portal | n |
|---|---|---|---|---|
| Smartwatch or other activity tracker | 64.7 | 411 | 49.1 | 391 |
| Uses only phone to monitor PA | 52.0 | 467 | 32.9 | 426 |

### *3.4 Willingness to copy or upload data*

Respondents who own a smartwatch or activity tracker to measure their PA are more willing to copy their data into a questionnaire than to upload the data to a research portal. In addition, respondents who own a smartwatch or activity tracker are more willing to copy or upload their data than respondents who use their phone to monitor their PA (see Table 2).

$Chi^2$ analyses showed that in both willingness to copy data and upload data, smartwatch and activity tracker owners were significantly more willing than respondents who only used their phone to monitor their PA ($Chi^2_{(1)} = 14.40$, *Cramèr's V = .128, p<.001 and* $Chi^2_{(1)} = 22.29$, *Cramèr's V = .165,* $p < .001$), respectively).

As shown in Table 3, respondents who own a smartwatch or activity tracker are more willing to copy their data into a questionnaire than respondents who monitor their PA on their phone. In addition, respondents who monitor their PA daily are more willing to copy their data into a questionnaire than respondents who monitor their PA less frequently. Respondents with an activity tracker are more willing to upload their PA data than respondents with a smartwatch or phone. Finally, respondents with an activity tracker are more inclined to wear a loaned meter than respondents with a smartwatch or phone.

### *3.5 PA of respondents with or without own device*

In total, 52.9% of respondents complies with the Dutch PA guidelines, a slightly higher percentage than in the general population: 51.9% (RIVM 2020). Monitoring one's PA with own devices is significantly related to this compliance, as is shown in Table 4.

With the exception of adhering to the guidelines for balance, people who monitor their activity comply to all aspects of the guidelines to a higher degree than people who do not monitor their PA. People with a smartwatch or other activity tracker do so to a larger extent than people who use their smartphone, but this difference only reaches significance in the adherence to the complete guidelines.

**Table 3.** Willingness related to intensity of use of own device (daily or sometimes).[1]

| | Copy data | | | | | Upload data | | | | | Wear loaned meter | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Daily | | Sometimes | | | Daily | | Sometimes | | | Daily | | Sometimes | | |
| | % | n | % | n | p (Cramèr's V) | % | n | % | n | p (Cramèr's V) | % | n | % | n | p (Cramèr's V) |
| Smartwatch | 72.4 | 210 | 48.8 | 86 | *** (.23) | 56.7 | 203 | 34.5 | 84 | *** (.20) | 64.8 | 210 | 61.6 | 86 | ns |
| Activity tracker | 76.7 | 90 | 48.3 | 58 | *** (.29) | 53.5 | 86 | 40.4 | 52 | ns | 76.7 | 90 | 51.7 | 58 | ** (.26) |
| Uses phone | 64.0 | 283 | 49.0 | 349 | *** (.15) | 42.0 | 264 | 34.7 | 319 | ns | 60.4 | 283 | 49.6 | 349 | ** (.11) |

*** $p < .001$, ** $p < .01$, ns not significant according to $Chi^2$ test

[1]Since the questionnaire asked the questions on copying and uploading per device and people could have multiple devices with differential answers per device, we report smartwatch and activity tracker separately here.

**Table 4.** Compliance to PA by activity tracker

| % | No tracking | Smartwatch or other device | Phone | ANOVA | Partial $\eta^2$ |
|---|---|---|---|---|---|
| Complies to complete guideline | $45.6_a$ | $63.9_b$ | $57.8_c$ | F(2,2230)=27.6*** | 0.024 |
| Complies to number of minutes | $70.5_a$ | $81.1_b$ | $77.0_b$ | F(2,2230)=11.5*** | 0.010 |
| Complies to bone and muscle guidelines | $66.6_a$ | $79.5_b$ | $74.7_b$ | F(2,2230)=15.9*** | 0.014 |
| Complies to balance guideline | $19.3_a$ | $25.9_b$ | $21.3_{ab}$ | F(2,2230)=4.5* | 0.004 |
| N | 1.136 | 482 | 616 | | |

* p < .05, *** p < .001 Note: version A and B of the survey are combined. Subscripts are based on LSD post-hoc tests. We also tested $Chi^2$ with post-hoc analyses of adjusted residuals by contingency table analysis (Beasley and Schumacker 1995; Not presented in this paper). $Chi^2$ and ANOVA show similar results. We present ANOVA here since the LSD post-hoc tests provide better insights into subgroups.

**Table 5.** Physical activity in follow-up study as measured by the ActivPAL.

| Activity | No device | Own device | ANOVA | partial $\eta^2$ |
|---|---|---|---|---|
| Total steps | 8770 | 12592 | F(1,43)=8.8** | .170 |
| Stepping time duration 10-20 min | 2.5 | 9.3 | F(1.43)=8.0** | .156 |
| Stepping time duration 20+ min | 2.1 | 10.9 | F(1.43)=6.6* | .133 |
| Stepping cadence 100 | 1879 | 4773 | F(1,43)=9.5** | .187 |
| MET value | 33.6 | 35.3 | F(1,43)=6.8* | .136 |
| Sitting time | 533.1 | 495.6 | F(1,43)=.4 | .009 |
| Standing time | 237 | 236 | F(1,43)=.00 | .000 |
| Primary lying time | 513 | 517 | F(1.43)=.02 | .000 |

* p<.05, ** p<.001. MET value is the metabolic equivalent of tasks. The MET value is calculated by dividing the oxygen uptake by the mass of a person in kilogram times 3.5 (Mortazavi et al. 2013).

This pattern is confirmed by the data of the follow-up study with the 45 respondents who wore the ActivPAL, half of whom did not have a personal device. Table 5 shows that respondents with a personal device take significantly more steps, walk longer times with high intensity, and expend more energy (MET) than respondents with no personal device. However, sitting, standing and lying time do not significantly differ between respondents with and without their own personal device.

## 4. Discussion and Conclusion

In this paper, we investigated the willingness of respondents to wear an accelerometer, the willingness to share data from their own PA meter, and the difference in PA between respondents with an own device and respondents with no device. The stated willingness of respondents to wear an accelerometer was high (48.7%). However, the number of respondents who actually wore an accelerometer for an acceptable number of days once invited was fairly low (n=45 out of 80 invites). The sample used in the follow-up study is small, however. The participation rate could be improved by providing more and better information and better procedures, e.g., to emphasize the saliency of the study or privacy. Furthermore, an important reason not to participate

in wearing a loaned accelerometer was "I do not move enough (now)." It is important to take this reason into account in further research, because people who are willing to participate in accelerometer research do not seem to reflect the general population in PA. We note that the study was conducted during the Covid-19 pandemic, which could have affected levels of physical activity. Although there was no lockdown, people were advised to work from home.

This research shows that there is a clear difference in self-reported level of activity between respondents who own a device to measure their PA (smartwatch and activity tracker such as a Fitbit or phone) and respondents who do not own such a device. Data of the follow-up study show a clear difference in level of activity measured with the ActivPAL between respondents who own a device to measure their PA and respondents who do not own such a device. We found no difference in sedentary behavior such as sitting, lying and standing, however. Note that we report bivariate analyses in this article, which do not control for any covariates. We checked for age effects but did not find any.

The willingness of respondents to share their personal data by copying device data into a questionnaire is high. The willingness to upload the data in a spread sheet to a research portal is slightly lower. Respondents who use their own device more frequently (daily) are more willing to upload their data than respondents who use their own device less frequently (sometimes). Further research is necessary to investigate the difference between data of a professional accelerometer (such as ActivPAL) and the data of respondents' personal devices (smartwatches and activity trackers), in order to decide what the optimal method is for measuring PA in the 21st century, considering aspects of data quality, costs, reliability, privacy, and usability: via survey, a respondent's own activity device or a professional (loaned) activity tracker.

In addition, future research should investigate how to improve representativeness of samples in PA studies. The low participation rates in the follow-up study might be related to the unfamiliar device (ActivPAL). People might be more willing to participate in a study of this kind if they were asked to wear a regular device, rather than a professional one (which they are likely to be unfamiliar with). With consumer-level activity trackers, respondents are more in control, and monitoring is integrated more effectively into respondents' lifestyle, which may increase willingness to participate in studies making use of these devices compared with professional devices (Loh et al. 2017). Scientific research often prefers research-based devices over commercial devices, however, since consumer companies develop their own equations and algorithms and work to improve them, making consumer level data less transparent. Another method that could increase response rates is the use of interviewers that can persuade respondents to participate, provide additional information, pick up the devices, etc.

Submitted: December 21, 2020 EDT, Accepted: April 12, 2021 EDT

## REFERENCES

Adams, S. A., C. E. Matthews, C. B. Ebbeling, C. G. Moore, J. E. Cunningham, J. Fulton, and J. R. Hebert. 2005. "The Effect of Social Desirability and Social Approval on Self-Reports of Physical Activity." *American Journal of Epidemiology* 161 (4): 389–98. https://doi.org/10.1093/aje/kwi054.

Beasley, T. Mark, and Randall E. Schumacker. 1995. "Multiple Regression Approach to Analyzing Contingency Tables: Post Hoc and Planned Comparison Procedures." *The Journal of Experimental Education* 64 (1): 79–93. https://doi.org/10.1080/00220973.1995.9943797.

Central Bureau of Statistics. 2018. https://www.cbs.nl/en-gb/news/2018/05/the-netherlands-leads-europe-in-internet-access.

Ferrari, P., C. Friedenreich, and C. E. Matthews. 2007. "The Role of Measurement Error in Estimating Levels of Physical Activity." *American Journal of Epidemiology* 166 (7): 832–40. https://doi.org/10.1093/aje/kwm148.

Fruin, M.L., and J.W. Rankin. 2004. "Validity of a Multi-Sensor Armband in Estimating Rest and Physical Activity Energy Expenditure." *Medicine & Science in Sports & Physical Activity* 36 (6): 1063–69.

Helmerhorst, Hendrik J. F., Søren Brage, Janet Warren, Herve Besson, and Ulf Ekelund. 2012. "A Systematic Review of Reliability and Objective Criterion-Related Validity of Physical Activity Questionnaires." *International Journal of Behavioral Nutrition and Physical Activity* 9 (1): 103. https://doi.org/10.1186/1479-5868-9-103.

Loh, Miranda, Dimosthenis Sarigiannis, Alberto Gotti, Spyros Karakitsios, Anjoeka Pronk, Eelco Kuijpers, Isabella Annesi-Maesano, et al. 2017. "How Sensors Might Help Define the External Exposome." *International Journal of Environmental Research and Public Health* 14 (4): 434–45. https://doi.org/10.3390/ijerph14040434.

Luiten, Annemieke, Joop Hox, and Edith de Leeuw. 2020. "Survey Nonresponse Trends and Fieldwork Effort in the 21st Century: Results of an International Study across Countries and Surveys." *Journal of Official Statistics* 36 (3): 469–87. https://doi.org/10.2478/jos-2020-0025.

Mortazavi, Bobak, Nabil Alsharufa, Sunghoon Ivan Lee, Mars Lan, Majid Sarrafzadeh, Michael Chronley, and Christian K. Roberts. 2013. "MET Calculations from On-Body Accelerometers for Exergaming Movements." In *2013 IEEE International Conference on Body Sensor Networks*, 1–6. IEEE. https://doi.org/10.1109/bsn.2013.6575520.

Prince, Stephanie A, Kristi B Adamo, Meghan Hamel, Jill Hardt, Sarah Connor Gorber, and Mark Tremblay. 2008. "A Comparison of Direct versus Self-Report Measures for Assessing Physical Activity in Adults: A Systematic Review." *International Journal of Behavioral Nutrition and Physical Activity* 5 (1): 56. https://doi.org/10.1186/1479-5868-5-56.

RIVM. 2020. "Lifestylemonitor." https://www.rivm.nl/leefstijlmonitor/bewegen.

Sallis, James F., and Brian E. Saelens. 2000. "Assessment of Physical Activity by Self-Report: Status, Limitations, and Future Directions." *Research Quarterly for Exercise and Sport* 71 (sup2): 1–14. https://doi.org/10.1080/02701367.2000.11082780.

Shephard, R. J. 2003. "Limits to the Measurement of Habitual Physical Activity by Questionnaires." *British Journal of Sports Medicine* 37 (3): 197–206. https://doi.org/10.1136/bjsm.37.3.197.

Ward, Dianne S., Kelly R. Evenson, Amber Vaughn, Anne Brown Rodgers, and Richard P. Troiano. 2005. "Accelerometer Use in Physical Activity: Best Practices and Research Recommendations." *Medicine & Science in Sports & Exercise* 37 (11): 582–88. https://doi.org/10.1249/01.mss.0000185292.71933.91.

Warnecke, Richard B., Timothy P. Johnson, Noel Chávez, Seymour Sudman, Diane P. O'Rourke, Loretta Lacey, and John Horm. 1997. "Improving Question Wording in Surveys of Culturally Diverse Populations." *Annals of Epidemiology* 7 (5): 334–42. https://doi.org/10.1016/s1047-2797(97)00030-6.

Welk, Gregory J., James J. McClain, Joey C. Eisenmann, and Eric E. Wickel. 2007. "Field Validation of the MTI Actigraph and BodyMedia Armband Monitor Using the IDEEA Monitor." *Obesity* 15 (4): 918–28. https://doi.org/10.1038/oby.2007.624.

Wijndaele, Katrien, Kate Westgate, Samantha K. Stephens, Steven N. Blair, Fiona C. Bull, Sebastien F. M. Chastin, David W. Dunstan, et al. 2015. "Utilization and Harmonization of Adult Accelerometry Data: Review and Expert Consensus." *Medicine & Science in Sports & Exercise* 47 (10): 2129–39. https://doi.org/10.1249/mss.0000000000000661.

## Appendix A: Questionnaire (translation of the original Dutch questionnaire)

### *Questionnaire I&O Research activity trackers and data donation*

This questionnaire is about physical activity. We ask you questions about your physical activity behavior and about devices with which that behavior can be measured.

The questions are part of a study that I&O Research is conducting together with the Central Bureau of Statistics and Utrecht University.

We'll start with a few questions about how often you move.

[SPLIT RUN: 50% gets block A, 50% gets block B]

**BLOCK A**

1. How many hours on average per week do you have moderately intensive physical activity?
You should think of the movement you have by, for example, cycling to work or the supermarket, housework or climbing stairs. So, this is different from sports!
• less than 30 minutes a week • 2 to 2.5 hours a week
• 30 minutes to 1 hour per week • 2.5 to 3 hours per week
• 1 to 1.5 hours per week • 3 to 3.5 hours per week
• 1.5 to 2 hours per week • more than 3.5 hours per week

2. How many days per week do you have at least 30 minutes (in total) of moderately intensive physical activity? This is the average number of days in an ordinary week. You should think of the movement you have by, for example, cycling to work or the supermarket, housework, or climbing stairs. So, this is different from sports!
• less than 1 day a week • 4 days a week
• 1 day a week • 5 days a week
• 2 days a week • 6 days a week
• 3 days a week • 7 days a week

3. How often per week on average do you do muscle or bone strengthening activities?
• Muscle strengthening activities include actions to improve strength, endurance, and size of the muscles. Consider, for example, running, football, tennis, or fitness.
• Bone strengthening activities consist of strength training and activities in which the body is loaded with its own weight. Think, for example, of climbing stairs, walking, running, and dancing.
• less than 1 day a week • 4 days a week
• 1 day a week • 5 days a week
• 2 days a week • 6 days a week
• 3 days a week • 7 days a week

4. How often on average per week do you do balance physical activities?
Balance physical activities are physical activities aimed at improving balance while standing or moving, such as standing on one leg or picking up an object from the floor. But also think of yoga, Tai Chi, or gymnastics.
• less than 1 day a week • 4 days a week
• 1 day a week • 5 days a week
• 2 days a week • 6 days a week
• 3 days a week • 7 days a week

**BLOCK B**

In your mind, take a normal week in recent months. Would you like to indicate how many days per week you performed the activities below and how much time on average you spent on such a day?

1. Commuting (back and forth)
If you have not performed an activity, enter 0. number of days per week average time per day
walk to/from work or school hours minutes
cycling to/from work or school hours minutes

2. Physical activity at work or school
If you have not performed an activity, enter 0. Number of hours per week
light and moderately strenuous work (sitting/standing work with occasional walking, such as desk work or walking work with light loads). hour
strenuous work (ongoing work or work that regularly requires heavy lifting). hour

3. Household activities
If you have not performed an activity, enter 0. number of days per week average time per day
light and moderately strenuous household work (standing work such as cooking, doing the dishes, ironing, feeding/bathing the child, and ongoing work such as vacuuming, shopping). hours minutes
strenuous housework (such as scrubbing floors, beating carpet, and running with heavy groceries). hours minutes

4. Free time
If you have not performed an activity,
enter a 0. number of days per week average time per day
walking hour minutes
cycling hour minutes
gardening hours minutes
DIY/DIY hours minutes

5. Sports
Which sport (s) do you play? Here you can write down a maximum of 4 sports, e.g., fitness / endurance training, tennis, running, football. If you don't play

sports, you can skip the question by clicking “next.” number of days per week
average time per day
hours minutes

6. Are you a member of a sports association or do you have a subscription to a fitness center, swimming pool, or another sports provider? Multiple answers possible.
• member of a sports association
• subscription to fitness center, swimming pool, or other sports provider
• neither

[from here everyone again; the numbering in the routes runs from here]

There are various devices that can measure whether someone is moving, and sometimes whether someone is walking, running, or cycling. Some devices can also measure heart rate.
1. Do you have one or more of the following devices that allow movement?
1. Do you have one or more of the following motion measurement devices? It doesn’t matter whether you use the device or not. Multiple answers possible.
a. a smartwatch: a digital watch that also measures other things, such as movement and heart rate
b. an activity tracker (a device that measures movement and can possibly also display the time)
c. an (app on your) phone that can measure movement
d. I don’t have any of the above devices

If 1 = a
2a. Are you using your smartwatch to measure your movement?
a. yes, daily
b. yes, occasionally / sometimes
c. I did, but not anymore
d. No

If 1 = b
2b. Are you using your activity tracker to measure your movement?
a. yes, daily
b. yes, occasionally/sometimes
c. I did, but not anymore
d. No

If 1 = c
2c. Do you use (the app on) your phone to measure your movement?
a. yes, daily
b. yes, occasionally/sometimes
c. I did, but not anymore
d. No

If 2c = a, b
2d. Have you put special physical activity apps on your phone to measure your movement?
a. yes
b. no, I'm using the default apps already on the phone

If 1 = a and / or 1 = b
2nd. What is the brand of your smartwatch or activity tracker? If you have multiple devices, you can start from the device you use most.
a. Apple
b. Samsung
c. Huawei
d. Fitbit
e. Garmin
f. Fossil
g. Xiaomi mi band / MiFit
h. Polar
i. Otherwise, namely.... (Open)

If 2a = b and / or 2b = b and / or 2c = b
3. How often do you track your movement with the device you use (most)?
a. 4 days a week or more
b. 1 to 3 days a week
c. 1 to 3 days a month
d. less than 1 day per month

If 2a = a, b and / or 2b = a, b and / or 2c = a, b
4. What measures the device you (most) use to measure your movement? Multiple answers possible.
a. number of steps
b. traveled distance
c. number of active minutes
d. calorie burning
e. heartbeat
f. duration of sleep
g. current and/or average speed
h. number of steps walked
i. type of activity (e.g., cycling, walking, running)
j. other, namely... (open)

Routing based on question 4: only show the aspects that have been checked in question 4
10. For the following matters, can you indicate what yesterday at the end of the day was the position of the device that you (most) use to measure your movement?

a. yes, the booth was .. (open)
b. I don't know how to read this from my device
c. I don't want to say this

a. number of steps
b. traveled distance
c. number of active minutes
d. calorie burning
e. heartbeat
f. duration of sleep
g. average speed
h. number of steps walked

If 2a = a, b and / or 2b = a, b and / or 2c = a, b
5. How accurately do you think the device you (most) use measures your movement?
a. My device measures my movement very accurately.
b. My device measures my movement quite accurately.
c. Some activities are measured accurately, but not all.
d. My device does not measure my movement as accurately.
e. My device does not accurately measure my movement at all.

If 5 = c, d, e
5a. Why do you have the impression that this device does not (sometimes) measure your movement accurately? Please consider:
• Do you have examples when your device is not measuring accurately?
• Does your device sometimes give different measurements in comparable situations?
• Are there any measurements that your device always makes wrong?
(open question)

If 2a = a, b and / or 2b = a, b and / or 2c = a, b
We are currently investigating ways in which we can collect data about physical activity. This provides useful information for future studies. It is possible to share data from your own device with I&O Research. This can be done, for example, by including data in a questionnaire.
7. Would you be willing to include the measured movements of your device in a questionnaire? If you have several devices, it is one of these devices.
a. Yes, I am willing to fill in the details of my device in a questionnaire.
b. Yes, I want to fill in some data, but not all of them.
c. No, I am not prepared to share this data with I&O Research via a questionnaire.
d. No, I am not prepared to share this data with I&O Research at all.

If 7 = a, b
7a. Over what period of time would you be willing to include the measured movements of your device in a questionnaire? Please enter the maximum

period over which you would like to share your device data.
a. 1 day
b. 1 week
c. 2 weeks
d. 3 weeks
e. a period longer than 3 weeks

If 7 = a, b, c
You can also provide I&O Research insight into data about your physical activity behavior via overviews that come directly from your device, for example by downloading them.
7b. Would you be willing to download an overview of your data and share it with I&O Research? You will receive information from us about how to do this and how we handle your data confidentially.
a. Yes, I would be willing to download and share data with I&O Research.
b. No, I am not willing to share my data in this way I&O Research.

If 7 = d or 7b = b
7c. What is the reason that you are not willing to share data about your movement behavior of your device with I&O Research? Multiple answers possible.
a. It takes me too much time.
b. The data is confidential.
c. I think this violates my privacy too much.
d. It seems too hard to do.
d. different, namely... (open)

If 7 = d or 7b = b
7d. Under what condition (s) would you be willing to share the data about your movement behavior of your device with I&O Research? Multiple answers possible.
a. if this were to be done completely anonymously
b. if this was made easy for me (pushing a button or taking a screenshot)
c. if I was convinced of the goal, for example scientific research
d. if this would earn me financial compensation
e. if I had a chance of a generous financial compensation (250 euros)
f. if this would provide me with insight into my physical activity behavior (add if necessary: compared to the Dutch physical activity standard)
g. if I were to receive advice about my physical activity habits
h. different, namely... (open)
i. under no circumstances will I share information about the movement behavior of my device with I&O Research

If 7d = d
7th. How high should a financial compensation be to ensure that you share data about your device movement behavior with I&O Research?
a. 20 euros

b. 40 euros
c. 80 euros
d. another amount, namely... (open)

If 1 = a, b, c
9a. You have a device that measures movement. For some studies, it is important that all participants use the same device. If we loan you an activity tracker for a week, would you be willing to wear this device for a week? Afterward, you send the device back to I&O Research, and we collect the data from it.
During this week, you also keep track of the physical activity data of your own device. You write this information down in a questionnaire at the end of each day.
As a thank you for your participation, you will receive Bol.com credit worth 20 euros afterward. You will also receive an overview with information about your physical activity behavior.
[Programmer: add an information balloon to the term "device" containing "The activity tracker is attached to the leg with a bandage. I&O Research will send you the tracker, accompanied by clear instructions. The tracker will be disinfected before it is shipped to you. After a week of wearing, return the tracker (free of charge)."]
a. Yes, I am willing to wear a device from I&O Research for a week to share the data and also keep a daily record of data from my own device
b. No, I am not willing to wear an I&O Research device and share the data.

If 1 = d
9b. You do not own a device that measures movement. If we lend you a device (activity tracker) for a week, would you be willing to wear this device for a week? Afterward, you send the device back to I&O Research, and we collect the data from it.
As a thank you for your participation, you will receive Bol.com credit worth 20 euros afterward. You will also receive an overview with information about your physical activity behavior.
[Programmer: add an information balloon to the term "device" containing "The activity tracker is attached to the leg with a bandage. I&O Research will send you the tracker with clear instructions. The tracker will be disinfected before it is sent to you. After a week of wearing, return the tracker (free of charge)."]
a. Yes, I am willing to wear an I&O Research device for a week and share the data.
b. No, I am not willing to wear an I&O Research device and share the data.

If 9b = b
9c. If we gave you an activity tracker that you can keep afterward, would you be willing to wear this device for a week and share the physical activity data with us?

a. Yes, I am willing to share a week's physical activity data if I can keep the device afterward.
b. No, that does not change my opinion. I am not willing to wear an I&O Research device and share the data.

If 9a = b or 9c = b
9d. Under what condition (s) would you be willing to wear an I&O Research activity tracker for one week and share the physical activity data with us? Multiple answers possible.
a. if this were to be done completely anonymously
b. if I was convinced of the goal, for example scientific research
c. if this would earn me a higher financial compensation
d. if I had a chance of a generous financial compensation (250 euros)
e. if this would provide me with insight into my physical activity behavior (add if necessary: compared to the Dutch physical activity standard)
f. if I were to receive advice about my physical activity habits
g. otherwise, namely...
h. Under no circumstances do I share data on the movement behavior of a device with I&O Research

If 9d = c
9e. How high should a financial compensation be to ensure that you wear an I&O Research activity tracker for one week and share data about your physical activity with us?
i. 40 euros
j. 60 euros
k. 80 euros
l. another amount, namely... [open]

These were all questions about your physical activity behavior and about devices with which that behavior can be measured.

Depending on the results, we may contact you shortly to ask if you would like to participate in a follow-up study.

In that case, you will receive an email with additional information about what participation means. On the basis of this email, you can then decide whether you actually want to participate.

**Appendix B: Representativity for gender, education, and age**

| | Questionnaire | | Accelerometer | | |
|---|---|---|---|---|---|
| | Gross sample | Net sample | Consent | Received | Wore ≥ 4 days |
| Gender | | | | | |
| Male | 47.7 | 49.6 | 47.2 | 53.2 | 51.2 |
| Female | 52.3 | 50.4 | 52.8 | 46.8 | 48.8 |
| Education | | | | | |
| Low | 23.8 | 23.8 | 18.9 | 23.4 | 23.3 |
| Medium | 39.0 | 38.2 | 38.2 | 36.1 | 34.9 |
| High | 37.2 | 38.1 | 43.0 | 40.4 | 41.9 |
| Age | | | | | |
| 18–34 | 20.7 | 18.1 | 22.0 | 29.8 | 30.2 |
| 35–49 | 20.2 | 17.2 | 20.9 | 25.5 | 23.3 |
| 50–64 | 34.6 | 35.9 | 35.3 | 23.4 | 23.3 |
| 65+ | 24.4 | 28.8 | 21.7 | 21.3 | 23.3 |
| N | 4.997 | 2.276 | 1.109 | 47 | 43 |

Note: We used no upper limit for age. The oldest respondent was 90 years old. Low education=0–2, medium education=3–5 and high education is 6–8 according to International Standard Classification of Education.