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RESEARCH NOTE

Sleep and BMI: Do (Fitbit) bands aid? [version 1; peer review: 2 approved with reservations]

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Abstract

Recent studies have used mainstream consumer devices (Fitbit) to assess sleep objectively and test the well documented association between sleep and body mass index (BMI). In order to further investigate the applicability of Fitbit data for biomedical research across the globe, we analysed openly available Fitbit data from a largely Chinese population. We found that after adjusting for age, gender, race, and average number of steps taken per day, average hours of sleep per day was negatively associated with BMI ($p=0.02$), further demonstrating the significant potential for wearables in international scientific research.

Keywords

sleep, BMI, fitbit, wearable

Open Peer Review

Approval Status

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27 Apr 2018

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2. **Maria R. Bonsignore** , University of Palermo, Palermo, Italy

Any reports and responses or comments on the article can be found at the end of the article.

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Author roles: McDonald L: Formal Analysis, Investigation, Methodology, Writing – Original Draft Preparation; Mehmud F: Funding Acquisition, Investigation, Methodology, Project Administration, Supervision, Writing – Review & Editing; Ramagopalan SV: Conceptualization, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Supervision, Writing – Review & Editing

Competing interests: LM, FM and SR are employees of Bristol-Myers Squibb Company.

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Introduction

The association between sleep and body mass index (BMI) is well known¹. Recently Xu and colleagues² showed that shorter sleep duration, as measured by a Fitbit wristband, was associated with a higher average BMI². These results importantly show the potential value of mainstream consumer devices for scientific research by providing objective sleep and physical activity data. A limitation of the Xu *et al.* study however, as noted by the authors², is the lack of diversity of ethnicity in their study population, with the majority of participants being of European descent. In order to assess the utility of wearables for global research we used data from a recently published study³ to investigate the relationship between sleep and BMI in a largely Chinese population.

Methods

Data was obtained from the study by Lim and colleagues³. In brief, this study generated Fitbit Charge heart rate (HR) data from a cohort of volunteers tracked for a median duration of 4 days³. The volunteers underwent comprehensive profiling

including activity tracking (step count and sleep tracking) using the Fitbit Charge HR wearable sensor and BMI measurement at day of recruitment. From the total cohort of 233 individuals contributing data³, association analyses were conducted on subjects who had valid measurements for all metric types and who had more than one day of sleep data.

To test the association between average hours of sleep and BMI multiple linear regression analyses were conducted using the 'statsmodels' package in python.

Results

Useable data was available for 212 individuals; the summary of their clinical and demographic characteristics are shown in Table 1.

A linear regression analysis showed that after adjusting for age, gender, race, and average number of steps taken per day, average hours of sleep per day was negatively associated with BMI ($p=0.02$): an hour increase in sleep per day was associated with approximately a 0.5 point decrease in BMI (Table 2, Figure 1).

Table 1. Cohort clinical and demographic characteristics.

Characteristic	Value
Mean Age in Years (Standard Deviation, SD)	46.6 (12.1)
No. of Females (%)	123 (58%)
No. of Chinese (%)	195 (92%)
Mean Hours of Sleep (SD)	6.5 (1.1)
BMI (SD)	23.6 (4.1)
Mean daily steps (SD)	10826 (3865)

BMI: Body mass index

Table 2. Multivariable linear regression analysis results for body mass index (BMI).

	Coefficient	P value
Intercept	29.21	<0.001
Age (per year increase)	0.0014	0.95
Sex (Male vs Female)	1.80	0.001
Race (Chinese vs other)	-3.35	0.001
Steps (per 1000 steps increase)	0.03	0.64
Average Sleep (per hour increase)	-0.54	0.02

Figure 1. Relationship between body mass index (BMI) and average hours of sleep.

Conclusions

In summary, we found that the findings of Xu and colleagues are consistent in a population of different ancestry. More generally, previous work^{2,3} and that described here demonstrates the significant potential for wearables in global biomedical research and further, as we used openly available data, this analysis shows the benefits of sharing observational data⁴.

Data availability

All data used in this study is available from the article by Lim *et al.* <https://doi.org/10.1371/journal.pbio.2004285>³

Grant information

Bristol-Myers Squibb supported this work.

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Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 03 September 2018

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Maria R. Bonsignore

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I agree with the previous reviewer about methodological remarks. While wearable devices may help in collecting data and significantly contribute to generate hypotheses or confirm results, their reliability has not been rigorously tested. An advantage of wearable devices is the possibility to collect large amount of data, which is not the case with this paper (n=212). Nevertheless, this work points to the possibility of increasingly available "big data", especially after appropriate validation studies.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 16 August 2018

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Eva Corpeleijn

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The paper confirms a weak inverse association between sleep time and BMI using a mainstream consumer activity tracker (fitbit). The aim is to demonstrate the potential for wearables in scientific research.

Because of this aim, it would be helpful to get additional information about feasibility aspects: what are the prerequisites for usability in terms of data collection, how many of the participants had useful data based on which criteria, what strategies are needed for quality control to obtain meaningful associations?

Definitions for 'useable data' should therefore be clarified.

Sensitivity analyses can provide answers to what elements are important and what factors are secondary for a meaningful data use of consumer trackers.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Lifestyle epidemiology; lifestyle interventions to prevent diabetes type 2; wearable technology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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