Impact of Wearable Devices on Patient Outcomes

Team 4

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Introduction

Wearable technology is an emerging supplement to healthcare. Systematic reviews of recent research suggest that the use of a wearable device (i.e., a fitness tracker or smartwatch) assists in improving patient engagement, increasing physical activity, and lowering patients' body mass index (BMI). Unfortunately, there are no established guidelines or recommendations for the frequency and duration of wearable device usage that would optimize their impact on patient health outcomes.

Overall aims and approach

During this study, we intend to define the preferred prescribed interval of wearable device use which yields the best patient outcomes. Adams et al. (2019) stated that "[…] population-attributable risk estimates found that ever-having smoked and obesity contributed the greatest amount to [cardiovascular disease] CVD, cognitive impairment, asthma, arthritis, diabetes, kidney disease, COPD, hypertension, and high cholesterol combined" (Adams et al., 2019). As such, we intend to focus on the control of obesity and the reduction of BMI through increased physical activity. Specifically, we aim to show a direct link between wearable device use and increased physical activity (as monitored by the wearable device and measured by a change in BMI).

Type of research design and sampling method

In our study, we aim to examine the causal relationship between the use of wearable devices and a decrease in BMI among participants with a BMI of 30.0 - 39.9. We hypothesized that more engagement with these devices would correlate with increased physical activity and thus a lower BMI. To control potential extraneous variables, we incorporated specific exclusion criteria. The study design included one control and four treatment arms.

The study duration was six (6) months from the first day of subject enrollment. Following enrollment, all subjects were randomly assigned to the control/treatment arms using the completely randomized, repeated measures study design. The subjects had follow-up appointments with their healthcare professionals at weeks 0 (first day of visit, baseline), 4, 8, 12, 16, 20 and 24. The following was collected at each visit:

- Weight (kg)
- BMI
- Total Hours/Day Wearable Device is Worn*
- Average Daily Step Count*
- Average Daily Active Minutes*

*Note: All control subjects will have a value of "0" or "null" for these variables as they are not given a wearable device and, therefore, are unable to accurately record findings.

Data set

The data set was created in Excel and imported into SPSS for analysis. A total of 7000 rows of data were amassed. This represents all 1000 study participants and the data compiled from each of their 7 visits (at Weeks 0, 4, 8, 12, 16, 20 and 24). Once the data was imported into SPSS, a table was generated with the descriptive statistics of the population (Table 1.1). Excel was also used to create a PIVOT table to illustrate pertinent averages derived from the dataset (Table 1.2).

A direct link to the Excel file containing all data, formulas and PIVOT tables is linked below for ease of reference. Appropriate permissions have been granted to all contributors and reviewers of the data in the shared file. Additionally, a copy of the file will be attached separately.

Wearable_Device_Data.xlsx

Population Descriptive Statistics

	N	Mean	Std. Deviation	Variance
Average Daily Step Count	3000	7982.462	2328.113	5420110.485
Average Daily Active Minutes	3000	80.079	7.934	62.949
Weight (kg)	7000	92.449	10.348	107.088
BMI	7000	34.527	2.882	8.307
BMI Change	7000	.141	3.811	14.527
Weight Change (kg)	7000	-.043	13.446	180.790

Std. Deviation and Variance use N rather than N-1 in denominators.

***Table 1.1* – Descriptive Statistics Results**

Group	Average Wearable Device Hours/Day	Average BMI Change	Average of Daily Active Minutes	Average of Daily Step Count
Control	0	0.04	#DIV/0!	#DIV/0!
Treatment Arm A	4	0.32	77.98	7998.52
Treatment Arm B	8	0.51	78.87	7978.96
Treatment Arm C	12	0.35	81.23	8007.55
Treatment Arm D	24	-0.23	82.30	7943.58
Grand Total	**5.952**	**0.14**	**80.08**	**7982.46**

***Table 1.2* – PIVOT showing averages of dataset.**

Statistical testing

Statistical testing was performed to investigate the relationship between adherence to wearable device usage, physical activity levels, and health outcomes in patients with obesity. We performed Pearson's correlation and multiple regression analyses to assess the relationship between wearable device usage, physical activity, and health outcomes in obese patients. Pearson's correlation provided insights into the linear relationship between each pair of variables. Multiple regression allowed us to quantify the contribution of each predictor to health outcomes while controlling for others. We used a significance level of $p < 0.05$ to determine statistical significance. Data was compiled and analyzed using SPSS and Microsoft Excel. The choice of methods was appropriate for our research question and data characteristics, and we checked all statistical assumptions to ensure robust findings.

Testing procedure

Variables were created for each of the following:

- Participant*
- Group*
- Total Hours/Day the Wearable Device is Worn*
- Study Week*
- Average Daily Step Count
- Average Daily Active Minutes
- Weight (kg)
- BMI
- BMI Change †
- Weight Change (kg) †

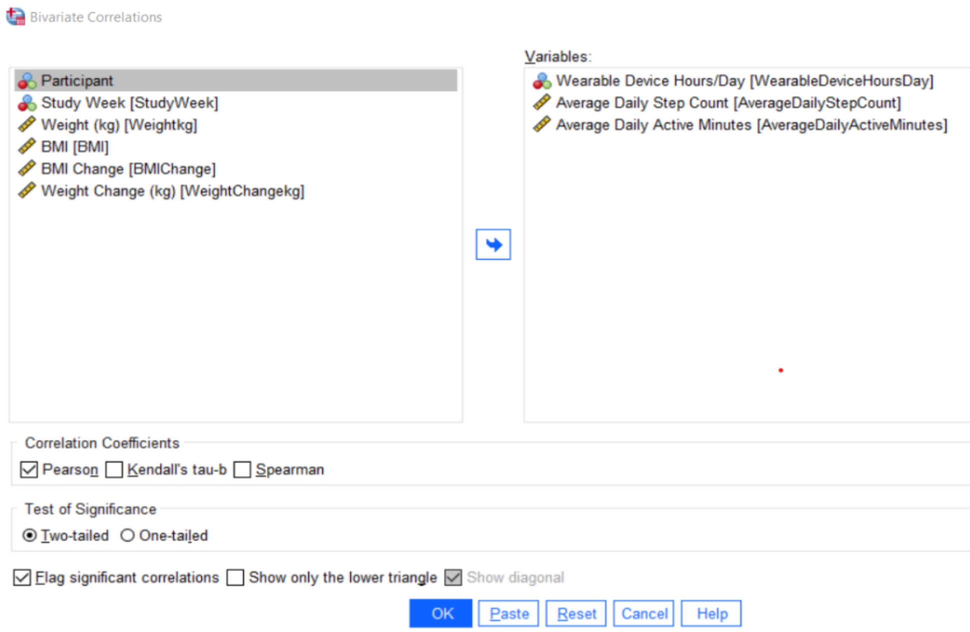
*Nominal variables only
†Calculated in Excel by subtracting each follow-up visit's data from Day 0 (baseline) for each participant

All data was imported into SPSS and the following analyses were performed:

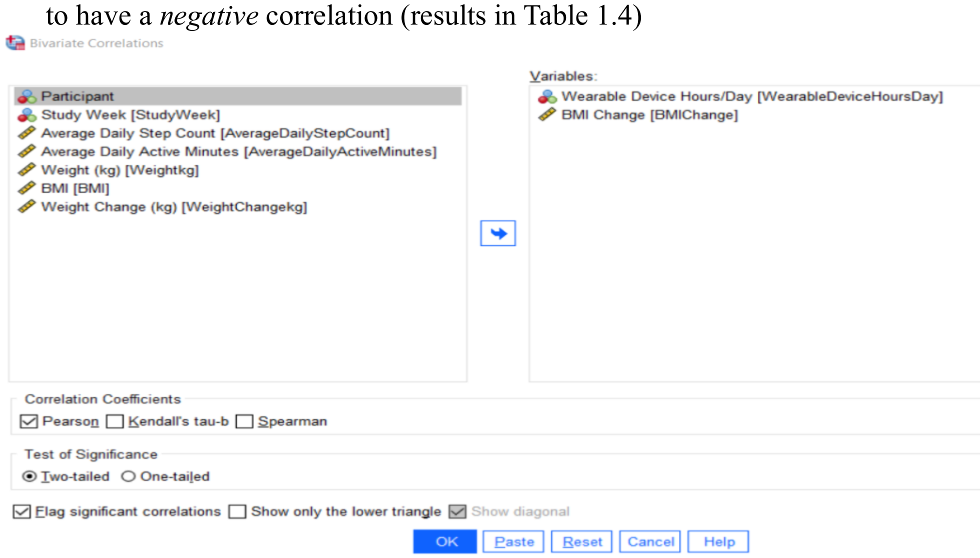
Pearson's Correlation Analysis

- We go to Analyze > Correlate > Bivariate....
- In the Bivariate Correlations dialog box, we move the variables we want to correlate (i.e., Wearable Device Hours/Day, Average Daily Step Count, Average Daily Active Minutes, BMI Change) to the Variables list.
- We make sure Pearson is checked under Correlation Coefficients.
- Click OK.

1. Pearsons's correlation to determine correlation coefficients between variables which we hypothesized to have a *positive* correlation (results in Table 1.3)

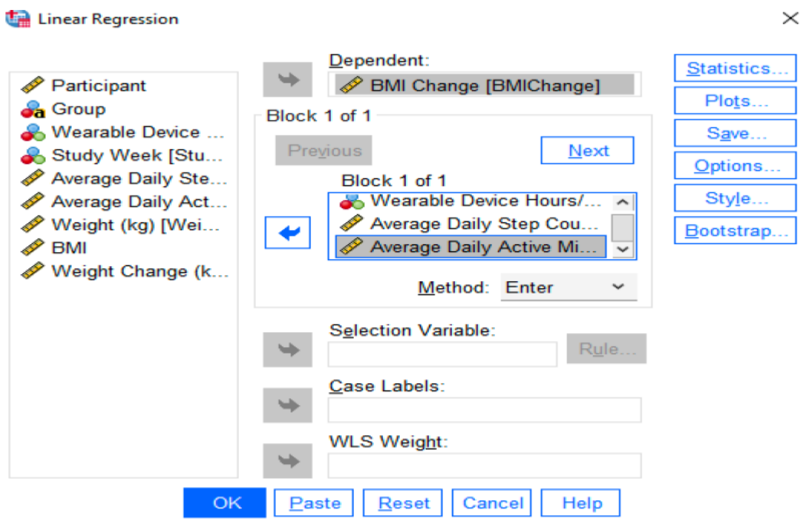


2. Pearsons's correlation to determine correlation coefficients between variables which we hypothesized to have a *negative* correlation (results in Table 1.4)



Multiple Regression Analysis

- We go to Analyze > Regression > Linear....
- In the Linear Regression dialog box, we moved our dependent variable (e.g., BMI Change) to the Dependent box.
- Move Our independent variables (e.g., Wearable Device Hours/Day, Average Daily Step Count, Average Daily Active Minutes) to the Independent(s) box.
- Click OK.
- (Results in Table 1.5)



Results

Using the Pearson correlation method, the results indicate a weak positive correlation to how often the device is worn and a subject's average daily active minutes. Conversely, a very weak *negative* correlation was noted between wearable device use and the average daily step count.

		Wearable Device Hours/Day	Average Daily Step Count	Average Daily Active Minutes
Wearable Device Hours/Day	Pearson Correlation	1	-.008	.203**
	Sig. (2-tailed)		.652	<.001
	N	7000	3000	3000
Average Daily Step Count	Pearson Correlation	-.008	1	.010
	Sig. (2-tailed)	.652		.577
	N	3000	3000	3000
Average Daily Active Minutes	Pearson Correlation	.203**	.010	1
	Sig. (2-tailed)	<.001	.577	
	N	3000	3000	3000

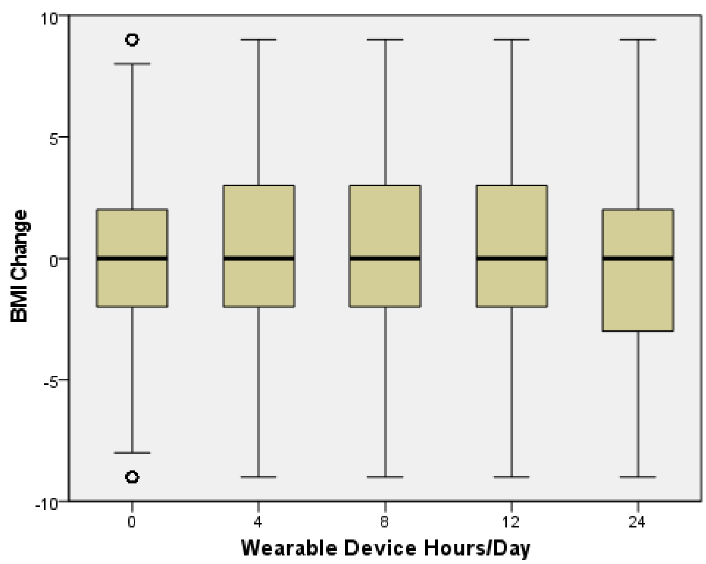
**. Correlation is significant at the 0.01 level (2-tailed).

Table 1.3 **– Correlation coefficients between variables hypothesized to have a positive correlation.**

Our primary focus for this study was to establish a causal relationship between a subject's adherence to the use of and engagement with wearable devices and a lower BMI. We hypothesized a negative correlation between increased use of the wearable device and decreased BMI. Unfortunately, the results were unable to support this hypothesis. Table 1.4 shows a very minor, albeit insignificant correlation coefficient of -.009. This is further illustrated in the box plot in Graph 1.1 which groups the BMI change by how many hours per day the wearable device was worn.

		Wearable Device Hours/Day	BMI Change
Wearable Device Hours/Day	Pearson Correlation	1	-.009
	Sig. (2-tailed)		.428
	N	7000	7000
BMI Change	Pearson Correlation	-.009	1
	Sig. (2-tailed)	.428	
	N	7000	7000

***Table 1.4* – Correlation coefficients between variables hypothesized to have a negative correlation.**



***Graph 1.1* – Box plot illustrating the correlation between wearable device use and BMI change.**

<u>Discussion</u>

The findings from our study contrasted with our initial hypotheses and some existing literature regarding the potential benefits of wearable devices on health outcomes. Our primary hypothesis was that increased usage of wearable devices would lead to increased physical activity and a subsequent decrease in BMI. However, our statistical analyses did not support this hypothesis.

The regression analysis revealed that variables related to wearable device usage, including 'Wearable Device Hours/Day', 'Average Daily Step Count', and 'Average Daily Active Minutes', did not significantly impact the changes in BMI. This was further reflected in the low R Square value, indicating that these variables accounted for a small fraction of the variability in the health outcomes.

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Average Daily Step Count, Average Daily Active Minutes, Wearable Device Hours/Day[b]	.	Enter

a. Dependent Variable: BMI Change

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.035[a]	.001	.000	4.049

a. Predictors: (Constant), Average Daily Step Count, Average Daily Active Minutes, Wearable Device Hours/Day

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	59.970	3	19.990	1.219	.301[b]
	Residual	49116.907	2996	16.394		
	Total	49176.877	2999			

a. Dependent Variable: BMI Change

b. Predictors: (Constant), Average Daily Step Count, Average Daily Active Minutes, Wearable Device Hours/Day

Table 1.5 **– showing the result of Multiple Regression analysis.**

The Pearson correlation analysis also showed a weak positive correlation between the duration of wearable device usage and average daily active minutes, and a very weak negative correlation between wearable device usage and average daily step count. These results suggest that increased device usage does not necessarily lead to a significant increase in physical activity.
Moreover, we found only a minor, statistically insignificant negative correlation between the use of wearable devices and changes in BMI. This was contrary to our expectations and highlights that increased engagement with wearable devices does not automatically translate into a lower BMI.

Conclusion

Our study aimed to explore the correlation between the frequency and duration of wearable device usage and improved health outcomes, specifically a reduction in BMI. However, the findings did not provide strong support for this correlation, indicating the complexity of the impact of wearable device usage in real-world settings. This suggests that factors beyond mere device usage, not captured in our study, might be influencing health outcomes. Additionally, our study revealed gaps in how wearable device engagement is tracked and documented, highlighting the need for more comprehensive measures.
The concept of "adherence" in the context of wearable device usage also needs to be reevaluated. Our study suggests that adherence should not be defined merely by the frequency and duration of device usage, but also by the quality of engagement and how it translates into health-related behaviors. In conclusion, while wearable devices hold potential in health improvement, our findings underscore the need for more nuanced understanding and comprehensive research to optimize their use and fully leverage their potential in improving health outcomes.

References:

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