

# Moderator effect of physical activity on stress and sleep relationship in daily life: an observational study using wearable devices

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## INTRODUCTION

In everyday life, sleep may be affected by several conditions, including stress. Stress has been shown to impact our physical and mental health. Perceived stress can affect sleep quantity, quality, and architecture, with a detrimental effect on emotional responses to daily stressors<sup>1,2</sup>. Moreover, poor sleep quantity/quality can increase the risk of severe medical diseases and mental disorders that in turn can have a detrimental effect on sleep<sup>3</sup>. However, some beneficial interventions of sleep and stress management seem to have a mediator effect on a stress-sleep relationship. Physical activity (PA) have been reported to prevent the negative effects of perceived stress on sleep<sup>4</sup>, and predict the level of stress and sleep quality in particular conditions like during the COVID-19 pandemic lockdown<sup>5</sup>. Studies on this topic have been conducting using self-report questionnaires or experimental conditions that actually may lead to biases in assessing stress and sleep parameters. Wearables can instead be usual instruments to assess different psycho-physiological parameters, in an ecological setting, covering a wider timespan. On these bases, the aim of the study was to conduct a preliminary analysis to investigate the relationship between PA, perceived daily stress (pdStress), and sleep parameters from data collected through Garmin and Apple wearable devices by LUCA app, a psycho-physiological well-being dedicated application helping the user to recognize and manage stress.

## MATERIALS AND METHODS

Data from Australian users have been collected for 14 consecutive days. No inclusion and exclusion criteria were applied. PA and sleep parameters were selected if present on both Garmin and Apple devices. We assessed: PA by daily calories consumption during active daily periods, and total steps; sleep as time spent asleep; pdStress as total score obtained from four specific daily, day-framed questions investigating the ability to relax, the presence of somatic, and emotional/cognitive symptoms [total score range: 0-12; the higher is the score the higher is the pdStress.]

Statistical analysis included linear mixed models, with pdStress total score as independent variable and sleep duration as dependent variable. PA parameters were added separately as moderators of pdStress and sleep relationship, with age, sex, and the brand device as covariates.

## RESULTS

The sample comprised 64 Australian users, aged between 20 and 60 years, with more prevalence of females. The sample was characterized by low to moderate levels of PA; mild levels of pdStress; and sleep duration as WHO's recommendations (6-8 hours per night).

The analyses showed a statistically significant inverse association between level of pdStress and sleep duration ( $p < 0.001$ ). This relationship was moderated by PA measured by active calories consumptions ( $p = 0.015$ ) and total steps ( $p = 0.038$ ), with higher activity levels resulting in a reduction of the strength of the inverse association between pdStress and sleep.

## CONCLUSION

Similar to the literature data, our results confirm the detrimental relationship between pdStress and nighttime sleep duration. Recent data found a longer sleep duration and an improvement in sleep quality, as a result of both acute and regular PA, during stress periods<sup>4</sup>. Moreover, data show the protective influence of PA on sleep duration and perceived stress, in particular, in less supportive environments<sup>5</sup>. Despite the limitations concerning the limited number of subjects, device-related recording errors, indirect sleep parameter recordings, and non-sophisticated PA measures, our results underline the importance of the investment in PA programs when daily stress conditions and sleep alterations occur.

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## REFERENCES

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**Table 1. Demographic features, PA, daily stress, sleep and type of device description of the sample**

	Subjects (n 64)
age, years; m±sd	40.78±9.1
gender, female; n (%)	37 (57.8)
pdStress; m±sd	3.55±2.1
steps, n; m±sd	6889±4422.9
active calories*	541.6±307.1
duration of sleep, minutes; m±sd	26758±5246.5
device, Garmin; n (%)	22 (34.4)

m, mean; n, number; sd, standard deviation; pdStress, perceived daily stress score; %, percentage; \*daily calories consumption during active daily periods. Data obtained from Garmin and Apple devices.