Open Journal of Psychiatry, 2022, 12, 188-202
https://www.scirp.org/journal/ojpsych
ISSN Online: 2161-7333
ISSN Print: 2161-7325

Effectiveness of a Fitbit Based Sleep and Physical Activity Intervention in an Early Intervention Psychosis (EIP) Service

Chris Griffiths[1*], Ksenija da Silva[2], Farah Hina[1], Sue Jugon[1], Gemma Willis[1], Samantha Yardley[1], Jonathon Walker[1], Marlene Kelbrick[1]

[1]Department of Innovation and Research, Northamptonshire Healthcare NHS Foundation Trust (NHFT), Northampton, UK
[2]Faculty of Health and Life Sciences, School of Psychological, Social and Behavioural Sciences, Coventry University, Coventry, UK
Email: *Chris.Griffiths@northampton.ac.uk

How to cite this paper: Griffiths, C., da Silva, K., Hina, F., Jugon, S., Willis, G., Yardley, S., Walker, J. and Kelbrick, M. (2022) Effectiveness of a Fitbit Based Sleep and Physical Activity Intervention in an Early Intervention Psychosis (EIP) Service. *Open Journal of Psychiatry*, **12**, 188-202.
https://doi.org/10.4236/ojpsych.2022.122015

Received: March 18, 2022
Accepted: April 19, 2022
Published: April 22, 2022

Abstract

Purpose: Compared to levels in the general population, people with experiences of psychosis have poorer physical fitness, more sedentary behaviour, lower physical activity, more sleep problems, and a higher incidence of insomnia. The aim of the current study was to examine the feasibility and impact of an intervention with the goal of addressing these issues. **Method:** Design: intervention with outcome measure data collection, with no control group. Forty-nine early intervention psychosis (EIP) service patients took part in an intervention: provision of a Fitbit, Fitbit software apps, sleep hygiene, and physical activity guidance, and three discussion sessions with clinicians. The sample consisted of 29 males and 20 females, with age range of 17 - 54 years, and average age of 29.5 years. Measures used were Fitbit activity and sleep data, and self-rated Warwick–Edinburgh Mental Wellbeing Scale (WEMWBS) and Positive and Negative Affect Schedule (PANAS). **Results:** WEMWBS scores significantly improved, with a medium effect size. PANAS negative affect (NA) dropped significantly. Analysis of Fitbit activity and sleep data yielded non-significant results. **Conclusion:** The intervention was acceptable to EIP patients and is feasible. Improvements in mental wellbeing and negative affect indicate the positive impact of the intervention on mental health. EIP services should consider assessing sleep quality and physical activity/exercise levels, and using this study's intervention to promote wellbeing and mental health within recovery focused practice. Further research could be undertaken through a sufficiently powered randomised control trial (RCT) comparing this intervention and treatment as usual (TAU).

Keywords

Fitbit, Wearables, Psychosis, Sleep, Exercise, Activity, Weight

1. Introduction

Due to factors such as antipsychotic medication, socioeconomic status, and lifestyle; compared to the general population, levels of physical activity and exercise are lower, and levels of sedentary behaviour are higher in people who experience psychosis [1] [2]. This inactivity is linked to more depression symptoms, lower wellbeing, greater hopelessness, lower quality of life, and physical health diseases, such as cardiovascular disease (CVD), stroke, hypertension, osteoarthritis, diabetes, and chronic obstructive pulmonary disease (COPD) [3] [4]. Lack of physical activity and poor quality of sleep are contributory factors to the reduced life expectancy of people who experience severe mental illnesses such as psychosis and schizophrenia, with a weighted average of 14.5 years of potential life lost [5].

Within the first three months of commencing antipsychotic medication for psychosis, patients (and particularly young patients) experience rapid increases in body weight [6]. The National Clinical Audit of Psychosis (NCAP) identified that 46% of patients required intervention for weight gain or obesity [7]. Weight gain is a cause of distress, reduced self-worth, and less physical activity [8]. In early psychosis, individuals often experience a decline in functioning, particularly social functioning, which can negatively impact their ability to engage in physical activity, therefore contributing to weight gain [9].

Effective sleep is critical for required occupational, social, emotional, cognitive, and healthy functioning [10] [11]. Sleep problems are common in people with symptoms of psychosis (rates of 80% reported) and impact negatively on functioning and wellbeing [12] [13] [14]. There can be problems getting to sleep, staying asleep, experiencing too little or too much sleep, nightmares, and erratic sleep patterns [15].

Poor sleep in people with psychotic symptoms is associated with reduced quality of life, increased suicide risk, cognitive impairment, and worse functioning and symptoms [16]-[21]. Insomnia is linked to psychotic experiences [22]. Severity of sleep disturbance and sleep-related impairment is associated with greater negative symptoms across motivation-pleasure deficits and diminished expression [23].

People with experience of psychosis report that good sleep quality (especially continuous and unbroken sleep) is highly valued and supports wellbeing and daytime functioning [24]. They report that effective sleep initiation and duration are important for participation in social activities and good quality of life [24]. Improved sleep for people with a psychosis diagnosis has been associated with enhanced social interaction, feeling energised, and improved engagement in activities [15].

A person's sense of wellbeing can be enhanced by regular physical activity; in addition, physical activity and exercise are preventive factors against at least 25 chronic medical conditions [3]. For people with experience of psychosis, engaging in physical exercise is associated with improved quality of life, cognition, functioning, and physical health, and reduced psychotic symptomatology [25]. Increasing physical activity and fitness during early psychosis can improve physical health and support functional recovery [26].

A meta-analysis showed that exercise can improve cognitive functioning among people with experience of psychosis [26]; specific exercise interventions can prevent antipsychotic-induced weight gain, improve cardiorespiratory fitness, improve symptomatic, neurocognitive, and metabolic outcomes, and promote recovery [26] [27] [28] [29]. However, individuals report that they do not find it useful to be told by a clinician what to do, individuals should be empowered to make decisions so that they feel in control and motivated through provision of knowledge to enable informed choices [9].

Sleep hygiene advice and support for sleep problems in psychosis may improve quality of sleep [13] [30]. However, there has been a lack of interventions to address sleep problems in psychosis [31]. Wearing and using the information provided by a wearable tracker (e.g. a Fitbit) can be helpful to increase physical activity, self-awareness of activity, motivation to engage in physical activity, and goal-setting/goal-achievement [32]. Feasibility and acceptability of consumer sleep monitoring technology (e.g., Fitbit) in psychosis has been found [33]. A Fitbit is the most widely used device in research projects and provides required access to Fitbit collected data [34].

Fitbits are helpful for increasing physical activity, self-awareness, motivation, and goal-setting [32]. Fitbit sleep detection is 95% accurate [35]. Activity trackers have been found to significantly reduce body weight due to improvements in self-regulated lifestyle [36]. People with schizophrenia diagnosis have found a Fitbit to be acceptable, motivating, and useful for enabling goal setting and healthier lifestyles [37]. Fitbit activity tracker can be a valuable part of lifestyle interventions for young adults with serious mental illness, which have been found to reduce CVD risk and weight, and improve cardiorespiratory fitness (CRF) [38].

A systematic review and meta-analysis of Fitbit-based interventions for healthy lifestyles found a significant reduction in weight and increases in physical activity (steps) and moderate-to-vigorous physical activity [39]. The review concluded that the use of Fitbit devices in interventions has the potential to promote healthy lifestyles in terms of physical activity and weight, and goal setting were a condition for better outcomes. Fitbit devices may be useful to health professionals for patient monitoring and support [39].

There have been calls for the development of structured lifestyle interventions to support early psychosis individuals to engage in healthy behaviours [9]. Evidence indicates that mental health patients require structure and support to assist them in physical health and lifestyle management and develop coping strategies, reduce sedentary behaviour, and increase health literacy [40]. Symptom reduction, increased functionality and improved health and wellbeing are key goals of EIP services [41]. When offered an exercise related intervention, people with experience of psychosis have responded favourably to the idea of using exercise to promote recovery [41].

Various interventions to improve the physical health of those with severe mental illness (SMI) have been trialled; including a recent large RCT of structured lifestyle education in schizophrenia; this highlighted the need and patient demand for interventions but had little effect [42]. However, more individualised exercise training programmes in early psychosis have been shown to be effective in improving symptomatology, functioning, and physical wellbeing [26] [43].

This present study takes the evidence of the value of Fitbit use, sleep hygiene, physical activity, goal setting, and individualised patient engagement and feedback, and incorporates these into a new intervention delivered in a United Kingdom (UK) National Health Service (NHS) EIP service. This project sought to determine whether EIP patients will wear a Fitbit and keep it charged. It seeks to investigate the effectiveness of this intervention and reports the findings. The research question is: "what is the effect on mental wellbeing, mental health, sleep, body weight, and physical activity".

2. Methods

2.1. Design

Intervention with outcome measures data collection baseline to follow-up, with no control group.

2.2. Procedure

Participants were required to download the Fitbit app to their smartphone, register with Fitbit using a username and a password, wear the device continually for the period of the intervention and charge it when required. At contact points, participants were reminded by clinical staff to wear the Fitbit and to charge it.

2.3. Measures

The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) is designed to measure the hedonic (subjective happiness, life satisfaction) and eudaimonic (psychological functioning, self-realisation) aspects of mental wellbeing [44]. WEMWBS has been validated in UK population samples [44] [45]. WEMWBS is a valid and reliable measure for a secondary care mental health service population [46]. It includes 14 self-report questions and Likert scale responses. Higher total "metric scores" indicate better mental wellbeing. WEMWBS has a minimal clinically important difference (MCID) of 3 [47].

Positive and Negative Affect Schedule (PANAS) measure both positive and negative affect and has been validated in UK population samples, and is valid and reliable in clinical and non-clinical samples [48]. The scale consists of 20 self-report questions on words that describe different feelings and emotions.

2.4. Fitbit Sleep Scores

Overall sleep score is a sum of individual scores in sleep duration (time asleep, more is scored higher), sleep quality (time in deep and REM sleep—more is scored higher) and restoration (sleeping heart rate & restlessness, how relaxed during sleep, with a high sleeping heart rate or too much tossing and turning lowering the score) [49]. Total score of up to 100. Most people in the general population get a score between 72 and 83; sleep score ranges are: excellent (90 - 100); good (80 - 89); fair (60 - 79); poor (less than 60) [49].

2.5. Fitbit Steps

Fitbit devices use a 3-axis accelerometer to count steps. This sensor also allows the determination of the frequency, duration, intensity, and patterns of movement [49].

2.6. Fitbit Wake after Sleep Onset (WASO)

Algorithms are used to record periods of wakefulness occurring after defined sleep onset [49]. Fitbit, in comparison to Polysomnography (PSG), showed no significant difference in measured values of WASO [50].

2.7. Fitbit REM

Recent-generation Fitbit models collectively utilize heart rate variability and body movement to assess sleep stages. Sleep-staging Fitbit devices show higher sensitivity (0.95 - 0.96) and specificity (0.58 - 0.69) values in detecting sleep epochs than non-sleep-staging devices and published values for regular wrist actigraphy [50].

2.8. Fitbit Data Parameters

Step data was ranked within basal activity (<2500 steps), limited activity (2500 - 4999 steps), low activity (5000 - 7499 steps), somewhat active (7500 - 9999 steps), active (10,000 - 12,499 steps), and very active (>12,500 steps) categories (Tudor-Locke *et al.*, 2009). Wake-time after sleep onset (WASO) was categorised as healthy (<21 minutes), fairly-healthy (21 - 41) or unhealthy (>41) [51].

2.9. Intervention

The intervention incorporated: a free to keep Fitbit (including instructions and set up), exercise and sleep hygiene advice sheets, as well as three patient engagement sessions with EIP clinical staff. Each engagement session offered support and encouragement; and facilitated a discussion regarding the use of the Fitbit, the application of exercise and sleep hygiene advice, as well as feedback.

2.10. Ethical Approval

Ethical approval was gained from United Kingdom's (UK) Health Research Authority (HRA); research ethics committee (REC) reference: 21/EM/0047. All participants provided informed consent. Informed written consent was obtained.

2.11. Recruitment and Participants

Participants were recruited from an NHS EIP service. Forty-nine participants undertook the intervention. The study was in two phases 22 participants in the first and 27 in the second, recruited between September and December 2020 (phase 1) and September and December 2021 (phase 2).

Inclusion criteria was 18 to 65 years old, a patient of the EIP service, based in the community and able to understand written and oral English. Exclusion criteria was, for a medical reason, could not wear a watch like device on their wrist, or no capacity to consent. Sampling was opportunistic, all eligible EIP patients were offered access.

The characteristics of the participants are presented in **Tables 1-3**. These show that participants were mostly men, of white British ethnicity. In the first study fourteen participants (8 males; 6 females) took part in the intervention. The characteristics of the participants are presented in **Table 1**.

2.12. Analysis

Analysis of change from baseline to 4 week point and correlational analysis were

Table 1. Participants' characteristics.

Study 1 (n = 22)	
Age	Range: 19 - 54 years *M* = 31.23 *SD* = 9.24
Gender	
Male	n = 13 (59%)
Female	n = 9 (41%)
Study 2 (n = 27)	
	Range: 17 - 50 years M = 28.4 SD = 8.98
	n = 16 (59.2%)
	n = 11 (40.7%)
Study 1 and 2 combined (n = 49)	
	Range: 17 - 54 years *M* = 29.5 *SD* = 8.65
	n = 29 (59%)
	n = 20 (41%)

Table 2. Analysis of change.

Rating scale	N	Mean ± SD [range]	Z	p
WEMWBS				
Wk1	49	49.78 ± 9.61 [30 - 68]	−2.09	0.037
Wk4	43	52.93 ± 9.25 [34 - 70]		
PANAS+				
Wk1	27	31.44 ± 8.51 [14 - 44]	−0.96	0.333
Wk4	23	31.93 ± 9.46 [16 - 49]		
PANAS−				
Wk1	27	16.56 ± 6.26 [10 - 34]	−1.60	0.111
Wk4	23	15.43 ± 6.43 [10 - 30]		

Table 3. Participant fitbit activity and sleep data according to defined categories.

Measure	Category	Pre	Post
Steps	Basal activity (<2500 steps)	0%	0%
	Limited activity (2500 - 4999 steps)	23.8%	22.2%
	Low activity (5000 - 7499 steps)	23.8%	22.2%
	Somewhat active (7500 - 9999 steps)	23.8%	27.8%
	Active (10,000 - 12,499 steps)	14.3%	11.1%
	Very active (>12,500 steps)	14.3%	16.7%
WASO	Unhealthy	14.3%	16.7%
	Fairly healthy	57.1%	50.0%
	Healthy	28.6%	33.3%

carried out using appropriate statistical tests. As continuous variables were not normally distributed, Wilcoxon signed-rank tests (Z) were used to compare baseline with post-treatment measures, together with the calculated effect sizes. Using non-parametric analysis (Pearson's chi-squared test and Mann-Whitney U test), the differences in demographic variables and between responders and non-responders on a number of variables were explored. All tests were 1-sided, at 5% level of statistical significance. Spearman's rho was used to calculate correlations. Data were analysed using the statistical software package SPSS Statistics 26.

3. Results

3.1. Outcome

Combining data from phases one and two the WEMWBS improved significantly from week 1 (49.8) to week 4 (52.9), $Z = -2.09$, $p = 0.037$). Medium effect size 0.32. We also found that PANAS negative affect dropped significantly (indicating that the patients had lower levels of negative affect at 4 weeks) and PANAS positive affect was reaching significance. There was no significant weight gain. Mean scores for mental health surveys at baseline and post intervention with Wilcoxon signed rank test z scores and significance level are presented in Table 2.

3.2. Measures of Assessment

There was a statistically significant positive correlation ($p < 0.01$) between WEMWBS and PANAS positive affect (PA) scales in weeks 1 and 4. PANAS negative affect (NA) scales correlated strongly between weeks 1 and 4 (Spearman rho = 0.588). However, there was no correlation between PANAS negative affect scale and WEMWBS and PANAS positive affect scale.

3.3. Changes in Activity and Sleep Patterns

Healthy physical activity levels have been observed in patients, both in week 1 (M = 8963, SD = 6407) and in week 4 (M = 9391, SD = 6190); however, there were large individual differences, and despite a small increase the activity levels did not change significantly ($p = 0.744$). Average daily sleep minutes increased from week 1 (M = 484, SD = 121) (eight hours and 4 minutes) to week 4 (M = 510, SD = 114) (eight hours and 30 mins); however, this increase (26 minutes) was not significant ($p = 0.272$). Similarly, the Fitbit sleep scores improved from 80.7% to 81.5% in week 4; however, the Wilcoxon signed-rank tests showed these trends were not statistically significant ($p = 0.158$). Statistically significant change occurred in the amount of REM sleep ($p = 0.023$), which increased from week 1 (M = 106, SD = 33) (21.9% of total sleep time) to week 4 (M = 115, SD = 37) (22.5% of total sleep time). These REM sleep percentages are similar to general adult (18 - 40) population norms (using more accurate Polysomnography [PSG] measurement tools) of around 21.5% [52].

3.4. Physical Activity and WASO

Relatively low physical activity levels were observed in patients both pre and post-intervention. Improvements on four of five activity levels, there was no statistically significant change. Improvements on one of the three WASO levels, none of the differences are statistically significant (presented in Table 3).

3.5. Correlations between Mental Wellbeing, Sleep, and Activity

Spearman's rho indicated a statistically significant positive relationship between PANAS negative affect scale and wake-time after sleep onset (WASO) (rho = 0.676). Weight was not associated with any other measures.

4. Discussion

This study investigated whether EIP patients will wear a Fitbit and keep it charged, and the impact of this intervention on mental wellbeing, mental health, sleep, body weight, and physical activity. This study provides evidence of feasibility and acceptability of the intervention. The findings showed that EIP patients are likely to wear a Fitbit and keep it charged, and attend engagement sessions. The findings suggest that EIP patients could benefit from the intervention.

Participant improvements on the WEMWB Sindicate a positive impact of the intervention on an individuals' wellbeing, subjective happiness, life satisfaction, self-realisation, and psychological functioning, and therefore, a potential positive impact on quality of life. Improvements on the PANAS negative affect (NA) scale indicates that participants experience less subjective distress and unpleasurable engagement; reduced negative activation. PANAS NA predicts anxiety and depression [48], and so the results indicate lower levels of anxiety and depression.

Although no significant improvement was found in physical activity or weight reduction, the small improvement in amount of physical activity and improvement on four of the five Fitbit defined activity levels (with the largest increase in the somewhat active [7500 - 9999 steps] range) and no weight gain provide some limited support for evidence that the Fitbit activity tracker can be a valuable part of lifestyle interventions for adults with serious mental illness [38]. There was little change and no significant change in sleep related factors, which perhaps indicates that sleep problems and improving sleep quality is difficult to address in this population and indicates the need for more focused treatment. Guidelines from the UK's National Institute for Health and Care Excellence (NICE) for the treatment of short-term insomnia are nonpharmacological interventions, e.g., insomnia cognitive behavioural therapy (iCBT), as the first method and, where measures fail, followed up with a brief course of a non-benzodiazepine hypnotic prescription [53].

The findings that most EIP patients will wear a Fitbit consistently, charge it and attend engagement sessions indicates that the intervention addresses findings that individuals do not want to be told by a clinician what to do, that it is beneficial to give individuals tools and feedback to empower individuals to make decisions so that they feel in control and motivated [9]. The findings indicate that this study's approach of providing structure and support to assist people in physical health and lifestyle management to encourage healthy lifestyles and increase health literacy [40], is an effective approach.

5. Limitations

Intervention was only conducted with participants who agreed to participate. Thus, it is possible more participants with better mental health (e.g., experiencing fewer psychotic symptoms) agreed to participate. In addition, there was a relatively small sample size limiting generalisability. The present sample was a reasonably homogeneous group: all had experience of psychosis symptoms. Data was collected from a single county in the UK, limiting generalizability. The Fitbit sleep data was very fragmented and so extracting meaningful sleep data was difficult.

6. Clinical Implications

Clinical staff working with people experiencing psychosis recognise the problems and value of sleep, but formal interventions to promote effective sleep are limited [54]. Interventions to enhance effective sleep should support motivation for behaviour change and should consider the impact of psychotropic medications [24]. Due to links with psychosis emergence and progression, EIP services should assess sleep quality and problems early and seek to provide information and interventions to address identified issues [22] [24]. Assessment of patients need to be recovery orientated and evaluate the impact of sleep on the ability to engage in the social and occupational roles individual patients' value, so that needs can be identified and addressed [24]. Intervening at the earliest stage to support healthy lifestyle and adopting a health promotion and illness preventative approach is more cost-effective and associated with better long-term outcomes [55]. Improved health and mental wellbeing are two aims of EIP services [41]. EIP service patients benefited from the project's relatively simple and low-cost intervention; therefore, it is recommended for introduction to EIP services.

7. Conclusion

There is a lack of effective physical activity/exercise interventions on offer for patients in EIP services [29]. As factors related to sleep and physical activity/exercise are interlinked, these factors need to be considered, assessed, and addressed together in EIP services. Due to the effects of anti-psychotics on body weight gain, fatigue, sleep quality, and physical activity, future research and healthy lifestyle interventions should take these effects into account and seek to reduce negative impact. Appropriately powered RCT of the intervention is warranted.

Acknowledgements

We wish to thank the staff at the NHS Trust for their support in recruitment, lived experience advisor, and the participants for their time.

Funding

This project has been funded by the Closing the Gap network. Closing the Gap is funded by UK Research and Innovation and their support is gratefully acknowledged (Grant reference: ES/S004459/1). Any views expressed here are those of the project investigators and do not necessarily represent the views of the Closing the Gap network or UKRI.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Soundy, A., Wampers, M., Probst, M., De Hert, M., Stubbs, B., Vancampfort, D., *et al*. (2013) Physical Activity and Sedentary Behaviour in Outpatients with Schizophrenia: A Systematic Review and Meta-Analysis. *International Journal of Therapy and Rehabilitation*, **20**, 588-595. https://doi.org/10.12968/ijtr.2013.20.12.588

[2] Vancampfort, D., Knapen, J., Probst, M., Scheewe, T., Remans, S. and De Hert, M. (2012) A Systematic Review of Correlates of Physical Activity in Patients with Schizophrenia. *Acta Psychiatrica Scandinavica*, **125**, 352-362. https://doi.org/10.1111/j.1600-0447.2011.01814.x

[3] Rhodes, R.E., Janssen, I., Bredin, S.S., Warburton, D.E. and Bauman, A. (2017) Physical Activity: Health Impact, Prevalence, Correlates and Interventions. *Psychology & Health*, **32**, 942-975. https://doi.org/10.1080/08870446.2017.1325486

[4] Schuch, F., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P., Reichert, T., *et al*. (2017) Physical Activity and Sedentary Behavior in People with Major Depressive Disorder: A Systematic Review and Meta-Analysis. *Journal of Affective Disorders*, **210**, 139-150. https://doi.org/10.1016/j.jad.2016.10.050

[5] Hjorthøj, C., Stürup, A.E., McGrath, J.J. and Nordentoft, M. (2017) Years of Potential Life Lost and Life Expectancy in Schizophrenia: A Systematic Review and Meta-Analysis. *The Lancet Psychiatry*, **4**, 295-301. https://doi.org/10.1016/S2215-0366(17)30078-0

[6] Correll, C.U., Manu, P., Olshanskiy, V., Napolitano, B., Kane, J.M. and Malhotra, A.K. (2009) Cardiometabolic Risk of Second-Generation Antipsychotic Medications During First-Time Use in Children and Adolescents. *JAMA*, **302**, 1765-1773. https://doi.org/10.1001/jama.2009.1549

[7] RCPsych (2019) National Clinical Audit of Psychosis: National Report for the Early Intervention in Psychosis Spotlight Audit 2018/2019. Healthcare Quality Improvement Partnership, London. https://www.rcpsych.ac.uk/docs/default-Source/improving-Care/ccqi/national-Clinical-Audits/ncap-Library/ncap-Eip-National-Report---Final-Online-20190807.pdf?sfvrsn=166d7fe7_2

[8] Watkins, A., Denney-Wilson, E., Curtis, J., Teasdale, S., Rosenbaum, S., Ward, P.B. and Stein-Parbury, J. (2020) Keeping the Body in Mind: A Qualitative Analysis of the Experiences of People Experiencing First-Episode Psychosis Participating in a Lifestyle Intervention Programme. *International Journal of Mental Health Nursing*, **29**, 278-289. https://doi.org/10.1111/inm.12683

[9] Carney, R., Cotter, J., Bradshaw, T. and Yung, A.R. (2017) Examining the Physical Health and Lifestyle of Young People at Ultra-High Risk for Psychosis: A Qualitative Study Involving Service Users, Parents and Clinicians. *Psychiatry Research*, **255**, 87-93. https://doi.org/10.1016/j.psychres.2017.05.023

[10] Cappuccio, F.P., D'Elia, L., Strazzullo, P. and Miller, M.A. (2010) Sleep Duration and All-Cause Mortality: A Systematic Review and Meta-Analysis of Prospective Studies. *Sleep*, **33**, 585-592. https://doi.org/10.1093/sleep/33.5.585

[11] Kripke, D.F., Garfinkel, L., Wingard, D.L., Klauber, M.R. and Marler, M.R. (2002) Mortality Associated with Sleep Duration and Insomnia. *Archives of General Psychiatry*, **59**, 131-136. https://doi.org/10.1001/archpsyc.59.2.131

[12] Blanchard, J.J., Savage, C.L., Orth, R.D., Jacome, A.M. and Bennett, M.E. (2020) Sleep Problems and Social Impairment in Psychosis: A Transdiagnostic Study Examining Multiple Social Domains. *Frontiers in Psychiatry*, **11**, Article No. 486. https://doi.org/10.3389/fpsyt.2020.00486

[13] Davies, G., Haddock, G., Yung, A.R., Mulligan, L.D. and Kyle, S.D. (2017) A Systematic Review of the Nature and Correlates of Sleep Disturbance in Early Psychosis. *Sleep Medicine Reviews*, **31**, 25-38. https://doi.org/10.1016/j.smrv.2016.01.001

[14] Reeve, S., Nickless, A., Sheaves, B., Hodgekins, J., Stewart, S.L.K., Gumley, A., *et al*. (2019) Sleep Duration and Psychotic Experiences in Patients at Risk of Psychosis: A Secondary Analysis of the EDIE-2 Trial. *Schizophrenia Research*, **204**, 326-333. https://doi.org/10.1016/j.schres.2018.08.006

[15] Waite, F., Evans, N., Myers, E., Startup, H., Lister, R., Harvey, A.G. and Freeman, D. (2016) The Patient Experience of Sleep Problems and Their Treatment in the Context of Current Delusions and Hallucinations. *Psychology and Psychotherapy: Theory, Research and Practice*, **89**, 181-193. https://doi.org/10.1111/papt.12073

[16] Hofstetter, J.R., Lysaker, P.H. and Mayeda, A.R. (2005) Quality of Sleep in Patients with Schizophrenia Is Associated with Quality of Life and Coping. *BMC Psychiatry*, **5**, Article No. 13. https://doi.org/10.1186/1471-244X-5-13

[17] Pompili, M., Lester, D., Grispini, A., Innamorati, M., Calandro, F., Iliceto, P., *et al*. (2009) Completed Suicide in Schizophrenia: Evidence from a Case-Control Study. *Psychiatry Research*, **167**, 251-257. https://doi.org/10.1016/j.psychres.2008.03.018

[18] Wulff, K. and Joyce, E. (2011) Circadian Rhythms and Cognition in Schizophrenia. *The British Journal of Psychiatry*, **198**, 250-252. https://doi.org/10.1192/bjp.bp.110.085068

[19] Bromundt, V., Köster, M., Georgiev-Kill, A., Opwis, K., Wirz-Justice, A., Stoppe, G. and Cajochen, C. (2011) Sleep-Wake Cycles and Cognitive Functioning in Schizophrenia. *The British Journal of Psychiatry*, **198**, 269-276. https://doi.org/10.1192/bjp.bp.110.078022

[20] Mulligan, L.D., Haddock, G., Emsley, R., Neil, S.T. and Kyle, S.D. (2016) High Resolution Examination of the Role of Sleep Disturbance in Predicting Functioning and Psychotic Symptoms in Schizophrenia: A Novel Experience Sampling Study. *Journal of Abnormal Psychology*, **125**, 788-797. https://doi.org/10.1037/abn0000180

[21] Ong, W.J., Tan, X.W., Shahwan, S., Satghare, P., Cetty, L., Ng, B.T., *et al*. (2020) Association between Sleep Quality and Domains of Quality of Life amongst Patients with First Episode Psychosis. *Health and Quality of Life Outcomes*, **18**, Article No. 114. https://doi.org/10.1186/s12955-020-01367-3

[22] Barton, J., Kyle, S.D., Varese, F., Jones, S.H. and Haddock, G. (2018) Are Sleep Disturbances Causally Linked to the Presence and Severity of Psychotic-Like, Dissociative and Hypomanic Experiences in Non-Clinical Populations? A Systematic Review. *Neuroscience & Biobehavioral Reviews*, **89**, 119-131. https://doi.org/10.1016/j.neubiorev.2018.02.008

[23] Blanchard, J.J., Andrea, A., Orth, R.D., Savage, C. and Bennett, M.E. (2020) Sleep Disturbance and Sleep-Related Impairment in Psychotic Disorders Are Related to Both Positive and Negative Symptoms. *Psychiatry Research*, **286**, Article ID: 112857. https://doi.org/10.1016/j.psychres.2020.112857

[24] Faulkner, S. and Bee, P. (2017) Experiences, Perspectives and Priorities of People with Schizophrenia Spectrum Disorders Regarding Sleep Disturbance and Its Treatment: A Qualitative Study. *BMC Psychiatry*, **17**, Article No. 158. https://doi.org/10.1186/s12888-017-1329-8

[25] Mittal, V.A., Vargas, T., Juston Osborne, K., Dean, D., Gupta, T., Ristanovic, I., *et al*. (2017) Exercise Treatments for Psychosis: A Review. *Current Treatment Options in Psychiatry*, **4**, 152-166. https://doi.org/10.1007/s40501-017-0112-2

[26] Firth, J., Carney, R., Elliott, R., French, P., Parker, S., McIntyre, R., *et al*. (2018) Ex-

ercise as an Intervention for First-Episode Psychosis: A Feasibility Study. *Early Intervention in Psychiatry*, **12**, 307-315. https://doi.org/10.1111/eip.12329

[27] Curtis, J., Watkins, A., Rosenbaum, S., Teasdale, S., Kalucy, M., Samaras, K. and Ward, P.B. (2016) Evaluating an Individualized Lifestyle and Life Skills Intervention to Prevent Antipsychotic-Induced Weight Gain in First-Episode Psychosis. *Early Intervention in Psychiatry*, **10**, 267-276. https://doi.org/10.1111/eip.12230

[28] Abdel-Baki, A., Brazzini-Poisson, V., Marois, F., Letendre, É. and Karelis, A.D. (2013) Effects of Aerobic Interval Training on Metabolic Complications and Cardiorespiratory Fitness in Young Adults with Psychotic Disorders: A Pilot Study. *Schizophrenia Research*, **149**, 112-115. https://doi.org/10.1016/j.schres.2013.06.040

[29] Larsen, L.Q., Schnor, H., Tersbøl, B.P., Ebdrup, B.H., Nordsborg, N.B. and Midtgaard, J. (2019) The Impact of Exercise Training Complementary to Early Intervention in Patients with First-Episode Psychosis: A Qualitative Sub-Study from a Randomized Controlled Feasibility Trial. *BMC Psychiatry*, **19**, Article No. 192. https://doi.org/10.1186/s12888-019-2179-3

[30] Klingaman, E.A., Palmer-Bacon, J., Bennett, M.E. and Rowland, L.M. (2015) Sleep Disorders among People with Schizophrenia: Emerging Research. *Current Psychiatry Reports*, **17**, Article No. 79. https://doi.org/10.1007/s11920-015-0616-7

[31] Krystal, A.D., Thakur, M. and Roth, T. (2008) Sleep Disturbance in Psychiatric Disorders: Effects on Function and Quality of Life in Mood Disorders, Alcoholism, and Schizophrenia. *Annals of Clinical Psychiatry*, **20**, 39-46. https://doi.org/10.1080/10401230701844661

[32] Chum, J., Kim, M.S. and Zielinski, L. (2018) Acceptability of the Fitbit in Behavioural Activation Therapy for Depression: A Qualitative Study. *Evidence-Based Mental Health*, **21**, 76. https://doi.org/10.1136/ebmental-2017-102763corr1

[33] Aledavood, T., Torous, J., Triana Hoyos, A.M., Naslund, J.A., Onnela, J.P. and Keshavan, M. (2019) Smartphone-Based Tracking of Sleep in Depression, Anxiety, and Psychotic Disorders. *Current Psychiatry Reports*, **21**, Article No. 49. https://doi.org/10.1007/s11920-019-1043-y

[34] Balbim, G.M., Marques, I.G., Marquez, D.X., Patel, D., Sharp, L.K., Kitsiou, S. and Nyenhuis, S.M. (2021) Using Fitbit as an MHealth Intervention Tool to Promote Physical Activity: Potential Challenges and Solutions. *JMIR mHealth and uHealth*, **9**, Article ID: e25289. https://doi.org/10.2196/25289

[35] Beattie, Z., Oyang, Y., Statan, A., Ghoreyshi, A., Pantelopoulos, A., Russell, A. and Heneghan, C.J.P.M. (2017) Estimation of Sleep Stages in a Healthy Adult Population from Optical Plethysmography and Accelerometer Signals. *Physiological Measurement*, **38**, 1968-1979. https://doi.org/10.1088/1361-6579/aa9047

[36] Kooiman, T.J., De Groot, M., Hoogenberg, K., Krijnen, W.P., Van Der Schans, C.P. and Kooy, A. (2018) Self-Tracking of Physical Activity in People with Type 2 Diabetes: A Randomized Controlled Trial. *CIN: Computers, Informatics, Nursing*, **36**, 340-349. https://doi.org/10.1097/CIN.0000000000000443

[37] Naslund, J.A., Aschbrenner, K.A., Barre, L.K. and Bartels, S.J. (2015) Feasibility of Popular M-Health Technologies for Activity Tracking among Individuals with Serious Mental Illness. *Telemedicine and e-Health*, **21**, 213-216. https://doi.org/10.1089/tmj.2014.0105

[38] Aschbrenner, K.A., Naslund, J.A., Gorin, A.A., Mueser, K.T., Browne, J., Wolfe, R.S., *et al*. (2022) Group Lifestyle Intervention with Mobile Health for Young Adults with Serious Mental Illness: A Randomized Controlled Trial. *Psychiatric Services*, **73**, 141-148. https://doi.org/10.1176/appi.ps.202100047

[39] Ringeval, M., Wagner, G., Denford, J., Paré, G. and Kitsiou, S. (2020) Fitbit-Based Interventions for Healthy Lifestyle Outcomes: Systematic Review and Meta-Analysis. *Journal of Medical Internet Research*, **22**, Article ID: e23954. https://doi.org/10.2196/23954

[40] McCloughen, A., Foster, K., Kerley, D., Delgado, C. and Turnell, A. (2016) Physical Health and Well-Being: Experiences and Perspectives of Young Adult Mental Health Consumers. *International Journal of Mental Health Nursing*, **25**, 299-307. https://doi.org/10.1111/inm.12189

[41] Brooke, L.E., Gucciardi, D.F., Ntoumanis, N. and Lin, A. (2020) Qualitative Investigation of Perceived Barriers to and Enablers of Sport Participation for Young People with First Episode Psychosis. *Early Intervention in Psychiatry*, **14**, 293-306. https://doi.org/10.1111/eip.12854

[42] Holt, R.I., Gossage-Worrall, R., Hind, D., Bradburn, M.J., McCrone, P., Morris, T., *et al*. (2019) Structured Lifestyle Education for People with Schizophrenia, Schizoaffective Disorder and First-Episode Psychosis (STEPWISE): Randomised Controlled Trial. *The British Journal of Psychiatry*, **214**, 63-73. https://doi.org/10.1192/bjp.2018.167

[43] Lambden, B., Berge, J. and Forsell, Y. (2018) Structured Physical Exercise and Recovery from First Episode Psychosis in Young Adults, the FitForLife Study. *Psychiatry Research*, **267**, 346-353. https://doi.org/10.1016/j.psychres.2018.06.001

[44] Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., *et al*. (2007) The Warwick-Edinburgh Mental Well-Being Scale (WEMWBS): Development and UK Validation. *Health and Quality of Life Outcomes*, **5**, Article No. 63. https://doi.org/10.1186/1477-7525-5-63

[45] Lloyd, K. and Devine, P. (2012) Psychometric Properties of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) in Northern Ireland. *Journal of Mental Health*, **21**, 257-263. https://doi.org/10.3109/09638237.2012.670883

[46] Bass, M., Dawkin, M., Muncer, S., Vigurs, S. and Bostock, J. (2016) Validation of Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) in a Population of People Using Secondary Care Mental Health Services. *Journal of Mental Health*, **25**, 323-329. https://doi.org/10.3109/09638237.2015.1124401

[47] Maheswaran, H., Weich, S., Powell, J. and Stewart-Brown, S. (2012) Evaluating the Responsiveness of the Warwick Edinburgh Mental Well-Being Scale (WEMWBS): Group and Individual Level Analysis. *Health and Quality of Life Outcomes*, **10**, Article No. 156. https://doi.org/10.1186/1477-7525-10-156

[48] Crawford, J.R. and Henry, J.D. (2004) The Positive and Negative Affect Schedule (PANAS): Construct Validity, Measurement Properties and Normative Data in a Large Non-Clinical Sample. *British Journal of Clinical Psychology*, **43**, 245-265. https://doi.org/10.1348/0144665031752934

[49] Fitbit (2022) Fitbit International Limited. https://myhelp.fitbit.com/s/home?language=en_US

[50] Haghayegh, S., Khoshnevis, S., Smolensky, M.H., Diller, K.R. and Castriotta, R.J. (2019) Accuracy of Wristband Fitbit Models in Assessing Sleep: Systematic Review and Meta-Analysis. *Journal of Medical Internet Research*, **21**, Article ID: e16273. https://doi.org/10.2196/16273

[51] Watson, N.F., Badr, M.S., Belenky, G., Bliwise, D.L., Buxton, O.M., *et al*. (2015) Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. *Journal of Clinical Sleep Medicine*, **11**, 591-592. https://doi.org/10.5664/jcsm.4758

[52] Floyd, J.A., Janisse, J.J., Jenuwine, E.S. and Ager, J.W. (2007) Changes in REM-Sleep Percentage over the Adult Lifespan. *Sleep*, **30**, 829-836. https://doi.org/10.1093/sleep/30.7.829

[53] NICE (2020) Managing Short-Term Insomnia (Less than 3months Duration). https://cks.nice.org.uk/topics/insomnia/management/managing-Short-Term-Insomnia-Less-3-Months/

[54] Rehman, A., Waite, F., Sheaves, B., Biello, S., Freeman, D. and Gumley, A. (2017) Clinician Perceptions of Sleep Problems, and Their Treatment, in Patients with Non-Affective Psychosis. *Psychosis*, **9**, 129-139. https://doi.org/10.1080/17522439.2016.1206955

[55] Tsiachristas, A., Thomas, T., Leal, J. and Lennox, B.R. (2016) Economic Impact of Early Intervention in Psychosis Services: Results from a Longitudinal Retrospective Controlled Study in England. *BMJ Open*, **6**, Article ID: e012611. https://doi.org/10.1136/bmjopen-2016-012611