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Longitudinal relations between needs satisfaction and physical activity among psychiatric patients with dual diagnoses

Marte Bentzen[a], Anders Farholm[b,d], Andreas Ivarsson [c] and Marit Sørensen[d]

[a]Norwegian School of Sport Sciences, Department of Teacher Education and Outdoor Studies, Oslo, Norway; [b]Faculty of Teacher Education, Østfold University College, Halden, Norway; [c]Halmstad University, Halmstad, Sweden; [d]Norwegian School of Sport Sciences, Department of Sport and Social Sciences, Oslo, Norway

ABSTRACT

Objectives: Studies including people with severe mental illness (SMI) have reported beneficial effects from physical activity (PA) on psychiatric symptoms, quality of life, and global functioning. However, it is important to be regularly physically active to obtain these effects. Using the motivational lens of self-determination theory, the aim of the current study was to explore the dynamic interplay between satisfaction of psychological needs (autonomy, competence, relatedness) in PA and the patients' weekly PA level.

Methods: The study had a longitudinal design, following 10 in-patients with dual diagnoses (SMI and addiction) over 12 weeks at a psychiatric ward offering physical activity as part of treatment. Data were collected 14 times with a questionnaire measuring psychological need satisfaction, while an accelerometer was used to objectively count steps to reflect participants average PA-level each week. To analyse the week-to-week relationships between the basic psychological needs and PA-level, the Bayesian dynamic p-technique analysis was used to explore both cross-sectional-, autoregressive- as well as cross-lagged effects between the constructs.

Results: The results indicated credible and strong positive autoregressive effects for all three psychological needs as well as for PA-level, and positive credible cross-sectional associations between all three psychological needs and PA-level. However, the cross-lagged effects were small and not credible for all three psychological needs in relation to PA-level.

Conclusions: In total, these results support the established positive relation between basic psychological need satisfaction and PA-level yet failed in finding any predictive effects between need satisfaction and PA-level.

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KEYWORDS
Self-determination theory; motivation; exercise; drug abuse; cross-lagged effects; behavioural change

Introduction

It is well established that people with severe mental illness (SMI) have substantially increased risk of mortality, morbidity, and poorer physical health than those without

CONTACT Marte Bentzen marte.bentzen@nih.no

SMI (De Hert et al., 2011; Nordentoft et al., 2013; Stubbs et al., 2016; Wahlbeck et al., 2011). Unhealthy lifestyle, such as inadequate nutrition, tobacco smoking, substance abuse, and sedentary behaviour, play a prominent role in explaining this inequitable disease burden experienced by people with SMI (Bobes et al., 2010; Davidson et al., 2001; McCreadie, 2002, 2003; Osborn et al., 2007; Scott & Happell, 2011). A positive change in one of these behaviours, namely physical activity (PA), might improve not only physical health, but also mental health.

The positive influence of PA on physical health has frequently been acknowledged (e.g. Haskell et al., 2007). PA, however, does not only improve physical health. Over the last decade strong evidence supporting the benefits of PA on psychiatric symptoms, quality of life, and well-being among individuals with SMI has been published (e.g. Dauwan et al., 2016; Rosenbaum et al., 2014; Schuch et al., 2016). To obtain these effects,however, it is, important to be physically active on a regular basis. Several barriers may make this difficult, but one of the major obstacles reported by both health care practitioners and individuals with SMI is related to motivation (Fraser et al., 2015; Glowacki et al., 2019; Happell et al., 2013).

Indeed, knowledge about motivation and how to successfully adopt and maintain a physically active lifestyle have been highlighted as one of the most important research questions within the field of SMI and PA (Vancampfort et al., 2016a, 2016b). This call for research has resulted in an increase in theory driven motivational research (Damschroder, 2020).

Self-determination theory [SDT] (Ryan & Deci, 2017) is a contemporary theoretical framework that has shown promising results in trying to understand the mechanisms for PA behaviours among people with SMI (Farholm et al., 2017; Vancampfort et al., 2015). According to SDT (Ryan & Deci, 2017), an environment that promotes satisfaction of the three psychological needs for autonomy, competence, and relatedness in PA, will enhance the quality of motivation, which in turn is likely to increase PA level (see Figure 1; adapted from Ng et al., 2012). The need for autonomy refers to an individual's perceptions of being the source of own actions and behaviours and is related to one's interests in and values toward the behaviour. The need for competence refers to feeling effective in one's own interaction with the environment, having the ability to experience a sense of capability and mastery. The need for competence refers to a subjective sense of mastery. The need for relatedness refers to the feeling of being connected with others and experience belonging. This includes both the reciprocal feelings where the individual feels connected with and cared for by others, but also the opportunity to care for others in the social environment (Deci & Ryan, 2000; Ryan & Deci, 2017). Further, SDT differentiates the quality of motivation between

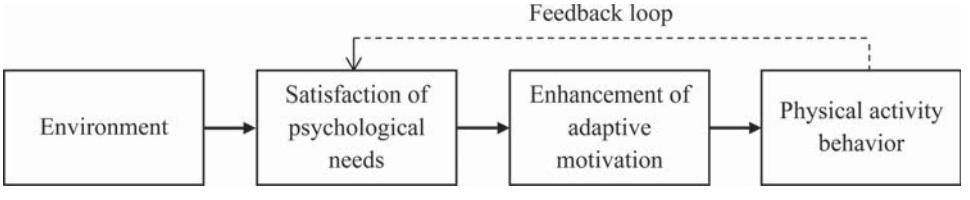

Figure 1. Motivational process for physical activity (*adapted from SDT-process model*, Ng et al., 2012).

autonomous and controlled motivation. Autonomous motivation captures engagement in behaviours with a sense of willingness, volition, personal interest and values, while engaging with controlled motivation means feeling pressured or with a sense of demand. Need fulfilment has a prominent role in facilitating more autonomous forms of motivation, which again have been shown to lead to greater persistence and higher levels of well-being while engaging in PA and health-related behaviours (Ntoumanis et al., 2021; Teixeira et al., 2012). The aforementioned studies have mainly focused on the quality of motivation and how motivation predicts PA behaviour, in other words the last part of the model in Figure 1. Furthermore, these studies have predominantly been cross-sectional, and thereby not been suitable to examine the fluctuations in need satisfaction over time in relation to fluctuations in PA, and the potential feedback loops from PA behaviour towards satisfaction of the three psychological needs, which again is presumed to influence quality of motivation (see dotted arrow in Figure 1).

It has been argued that the co-occurrence of mental illness and drug abuse disorder is so common that it can be considered more of an expectation than an exception when examining individuals with severe mental illness (Buckley, 2006). Depending on type of SMI and type of substance abuse or dependence, numbers of co-occurrence have been reported to be in the range of 47%–56% (Kessler et al., 2005; Regier et al., 1990). Surprisingly little evidence on how to facilitate and promote PA in this population exists. Studies examining motivation and health behaviour among individuals with SMI often exclude individuals with dual diagnoses (e.g. Choi & Medalia, 2010; Daumit et al., 2013) or they may be eligible for participation but are not distinguished from participants without dual diagnosis (Beebe et al., 2011, 2012). Thus, there is a need to enhance our knowledge on how to promote PA in individuals with dual diagnosis.

The purpose of the present study was to explore the dynamic interplay between satisfaction of each of the psychological needs of autonomy, competence and relatedness during PA and the weekly PA level for inpatients with dual diagnosis.

Methods

Design, participants and data collection

The current study had longitudinal design with multiple data collections. More precisely, data was collected 14 times over a period of 12 weeks. The two first weeks the questionnaire was answered twice to get frequent measures at the start of the project and making the participants familiar with the questionnaire. From week three to twelve, the questionnaire was answered every Wednesday to ensure regularity in the data collection for the rest of the period. The study was conducted at a psychiatric ward for patients with SMI (e.g. schizophrenia and psychotic disorders, depressive and anxiety disorders, trauma and stress-related disorders, and personality disorders), and addiction (e.g. drug, alcohol and gaming). Patients at the institution have in general complex and severe disorders, and thus the patients normally stay at the institution for at least 12 weeks. Daily PA is integrated as a part of treatment by activities both in-house (e.g. household) or outside (e.g. gardening, farm work), and activity groups going for hikes, more traditional exercise activities such as strength training and spinning, or body awareness-groups. It is

mandatory to take part in the daily work activities, while it is encouraged to participate in activity groups and exercise.

Inclusion of patients to the study went on consecutively during a six-month period. All participants at the institution, regardless previous PA level or interest in PA, were evaluated for inclusion in the study. Recruitment and evaluation of participants was done in collaboration with the head psychiatrist, using the following inclusion criteria: Planned hospitalisation ≥ 12 weeks, > 18 years old, and patients having informed consent competence. Exclusion criteria: Patients performing compulsory exercise (e.g. obsessive-compulsive disorders, eating disorders) or having physical health-related contraindications hindering them to participate in the PA-program at the ward (e.g. cardiac problems, knee injuries). Twenty-one patients were evaluated to fit the inclusion criteria and initially agreed to participate. Eleven patients dropped out of the study because they did not want to participate anymore or ending the treatment earlier than planned. The data of these participants were not available to the researchers for ethical reasons as the participants either actively withdrew from study or left before we were able to ask them if the data collected so far could be used in the study. This resulted in 10 participants completing the study protocol of 12 weeks (completion rate: $10/21 = 47.62\%$).

Data collection and measures

The participants' gender, age, and diagnoses (ICD-10) were registered by the staff at the ward at the beginning of the study. Also, the head psychiatrist scored the participants on the symptom and function dimensions of the Global Assessment of Functioning (GAF) (Pedersen & Karterud, 2012). Further, the data were collected with assistance of the sports pedagogue at the ward, resulting in 14 measurement points over 12 weeks. We used an adapted version of the Basic Psychological Needs for Exercise Scale (Vlachopoulos, Ntoumanis, & Smith, 2010) to assess degree of satisfaction of the three psychological needs for autonomy, competence, and relatedness in PA. The questionnaire was adapted to the local language by replacing the term 'exercise' with 'physical activity'. Each need was assessed by four items and example items for each need are: 'The physical activity is highly compatible with my choices and interests' (autonomy), 'I feel that I execute my physical activity in an efficient way' (competence), and 'I feel very much at ease with the other physical activity participants' (relatedness). Each item was answered on a 7-point Likert-scale ranging from 1 (*strongly disagree*) to 7 (*strongly disagree*). The scale has previously indicated good internal consistency among Norwegian psychiatric outpatients ($\alpha = .95$; Farholm, Sørensen, & Halvari, 2017b).

The participants wore a wristwatch with an accelerometer (Polar A300, Polar Electro Oy, Kempele, Finland) during the whole study-period of 12 weeks (not during the night). The sports pedagogue at the institution was in charge of downloading the activity data while the participants were answering the questionnaire. He also helped them charge battery and reminded them daily to wear the watch. The count of steps was deliberately selected to reflect the range of PA offered (e.g. hiking, gardening, group-exercise) during treatment and thus yielding an objectively measured overall, daily average PA-level for each participant. Moreover, individuals with SMI also tend to engage in significantly lower threshold PA than moderate to vigorous PA (e.g. Schuch et al., 2017) and for

this particular study it was of interest to examine an overall expression of the PA-pattern among the participants. To be included in the analysis, the wear time had to be ≥8 h between 06.00 and 24.00. This was chosen to reflect a valid estimation of wear time in order to reduce the burden of the participants who were asked to wear the watch for 12 weeks (Herrmann et al., 2013). The following standards have been suggested to describe overall PA level according to steps/day (Hill & Wyatt, 2006): Sedentary: < 5000; Low active: 5000–7499; Somewhat active 7500–9999; Active: 10,000–12,499; Highly active: ≥ 12,500.

Ethics

A 'code of ethics' based on the European Federation of Professional Psychologistś Associations was developed to guide the work at all stages in this project (Lindsay, 2011). A written agreement was developed and signed by the psychiatric ward and the research institution regarding ethics within the research project and data handling. The participants were given information about the study and signed an informed consent prior to inclusion in the study. The Regional Committees for Medical and Health Research Ethics in Norway (2015/1536) approved the study.

Data analyses

To test if there was a credible change in steps during the study period a Bayesian two-level regression analysis was performed. Within the model steps were, on within-person level, regressed on time.

We performed Bayesian dynamic p-technique (DPT) analyses to investigate the relationships between the three basic psychological needs and the average number of steps per week. As the basic psychological needs data were collected twice in the first and second week, an average score for week one and two were aggregated before performing further analyses. The DPT analysis is particularly useful when examining relationships between two dynamic constructs over time, especially in studies with small sample sizes (Nelson et al., 2011). For the analyses we used a lagged covariance matrix with both synchronous and time-lagged information included (Little et al., 2006). In the DPT analysis, it is possible to specify the following paths: (a) cross-sectional associations; (b) autoregressive effects within constructs over time; and (c) cross-lagged effects between different variables over time. For all paths, the average estimates are provided (Nelson et al., 2011).

All analyses were performed in M*plus* 8.1, where missing data was handled using Full Information Maximum Likelihood (FIML). Separate models were estimated between each of the three basic psychological needs (i.e. autonomy, competence, relatedness) and the number of steps. The Markov Chain Monte Carlo simulation procedures with Gibbs sampler was used in all analyses (Muthén & Asparouhov, 2012). We estimated all models using 100,000 iterations (50,000 are used as burn-in by default in M*plus*). A potential scale reduction (PSR) factor around 1 was considered as evidence of convergence (Kaplan & Depaoli, 2012). Model fit was evaluated using the posterior predictive *p* (PP*p*) value and its accompanying 95% confidence interval. 'A positive lower limit is in line with a low posterior predictive *p* value and indicates poor fit'

(Muthén & Asparouhov, 2012). For all parameters, we calculated a 95% credibility interval (CI). The 95% CI represents the probability that the parameter of interest, given the data, is placed within the interval. In the present study, we followed the recommendations from Zyphur and Oswald (2015), and rejected the null hypothesis if the 95% CI did not include zero. Because of difficulties to find adequate priors from previous studies, we used the default non-informative prior distribution in M*plus* (Asparouhov & Muthén, 2010).

Results

Demographic data

Ten participants completed the study protocol of 12 weeks: 4 males, 6 females; Age, $M = 31.2$, $SD = 7.6$ (Range 19-44). Nine of the patients were hospitalised due to dual diagnoses (SMI and addiction), while 1 participant was hospitalised due to SMI only. On a group level, these were the diagnoses (ICD-10) of the participants: Residual schizophrenia (F20.5), Psychotic disorder (F19.5), Recurrent depressive disorder (F33), Social phobias (F40.1), Dystemia (F34.1), Specific personality disorder (F60), Schizoaffective disorders (F25), Post-traumatic stress disorder (F43.1); Dependence syndrome (F19.2), Mental and behavioural disorders due to use of opioids (F11.24), Impulse disorders gaming (F63), Harmful use alcohol (F10.1), Harmful use cannabinoids (F121).As a description for the population as a group, the GAF score on symptoms were $M = 44.40$ ($SD = 9.43$) and functioning $M = 46.30$ ($SD = 8.82$).

Physical activity level

The PA level per day for the 12 weeks for each participant is presented in Table 1. Based on the suggestion of Hill and Wyatt three participants could be characterised as 'Sedentary', two as 'Low active', one as 'Somewhat active', two as Active, and two as Highly active. A two-level regression analysis, indicating good model fit (PP$p = 0.43$, 95% Confidence Interval (CI) = [−9.39, 12.00]) showed that there was a positive credible effect of time on steps ($B = .19$, 95% CI = [.05, .32]). More specifically, this result indicates an average increase in steps during the study period.

Table 1. Average activity level per day over 12 weeks for each participant.

ID	Average step/day	Activity level
1	4952	Sedentary
2	6285	Low active
3	3435	Sedentary
4	12,779	Highly active
5	3333	Sedentary
6	10,461	Active
7	5837	Low active
8	11,871	Active
9	15,411	Highly active
10	9275	Somewhat active

Note: Activity level; Sedentary: < 5 000; Low active: 5000–7499; Somewhat active 7500–9999; Active: 10,000–12,499; Highly active: ≥ 12,500 (Hill & Wyatt, 2006).

Dynamic interplay: satisfaction of need for autonomy and steps

The model showed good fit to data (PPp = 0.47, 95% Confidence Interval = [−15.37, 15.32]) (Figure 2). The two independent variables (i.e. autonomy and steps) could explain 57% of the variance in autonomy and 54% of the variance in steps the following week. There were credible autoregressive effects for both steps (β = .72, 95% CI = [.58, .85]) and autonomy (β = .69, 95% CI = [.55, .82]). The result showed a credible positive correlation between the two variables (r = .21, 95% CI = [.01, .40]). There were no credible cross-lagged effects for neither the path from steps to autonomy the following week (β = .13, 95% CI = [−.01, .27]) nor for the path from autonomy to steps the following week (β = .03, 95% CI = [−.11, .18]).

Dynamic interplay: satisfaction of need for competence and steps

The model showed good fit to data (PPp = 0.47, 95% Confidence Interval = [−15.37, 15.39]) (Figure 3). The two independent variables (i.e. competence and steps) could explain 58% of the variance in competence and 54% of the variance in steps the following week. There were credible autoregressive effects for both steps (β = .74, 95% CI = [.60, .88]) and competence (β = .69, 95% CI = [.55, .83]). The result showed a credible positive correlation between the two variables (r = .33, 95% CI = [.314.50]). There were no credible cross-lagged effects for neither the path from steps to competence the following week (β = .12, 95% CI = [−.01, .26]) nor for the path from competence to steps the following week (β = −.02, 95% CI = [−.15, .14]).

Dynamic interplay: satisfaction of need for relatedness and steps

The model showed good fit to data (PPp = 0.48, 95% Confidence Interval = [−15.42, 15.32]) (Figure 4). The two independent variables (i.e. relatedness and steps) could explain 74% of the variance in relatedness and 54% of the variance in steps the following

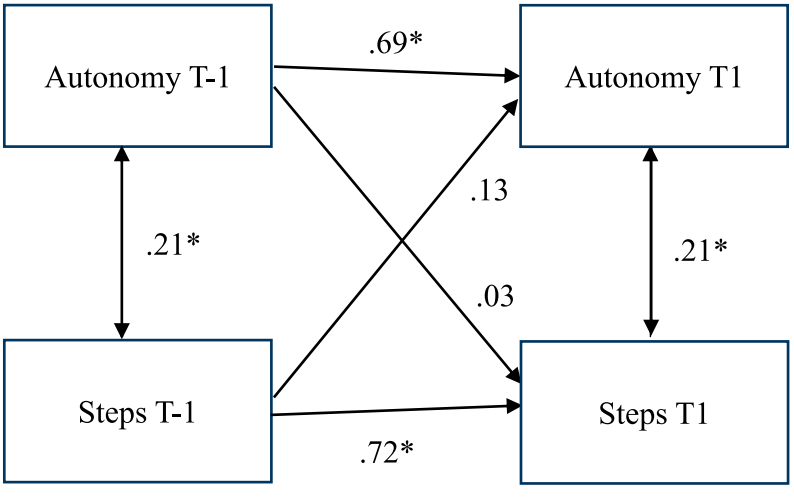

Figure 2. Model with standardised estimates for the structural paths: Autonomy and steps.

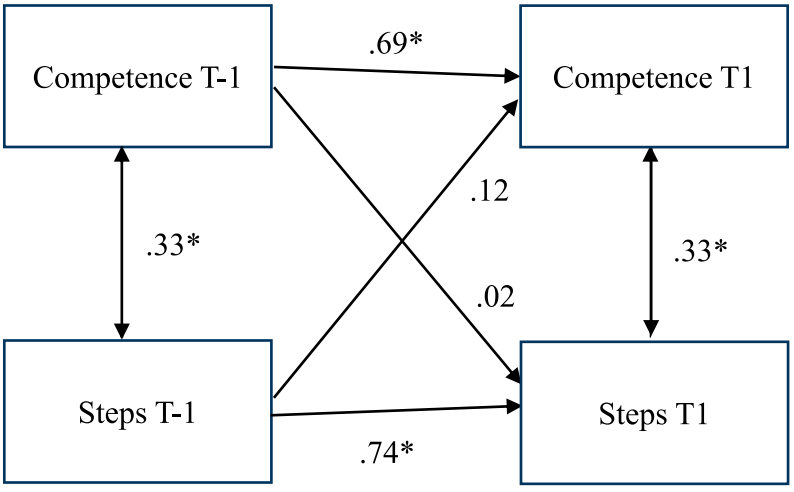

Figure 3. Model with standardised estimates for the structural paths: Competence and steps.

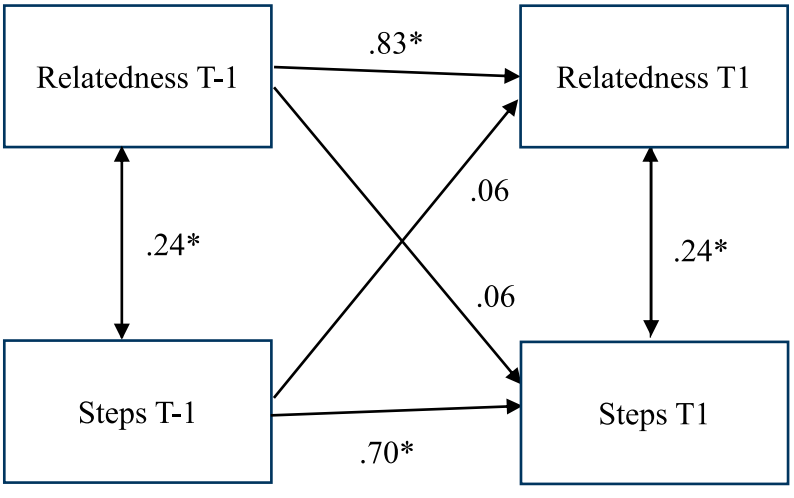

Figure 4. Model with standardised estimates for the structural paths: Relatedness and steps.

week. There were credible autoregressive effects for both steps ($\beta = .70$, 95% CI = [.56, .84]) and relatedness ($\beta = .83$, 95% CI = [.72, .93]). The result showed a credible positive correlation between the two variables ($r = .24$, 95% CI = [.05, .42]). There were no credible cross-lagged effects for neither the path from steps to relatedness the following week ($\beta = .06$, 95% CI = [−.05, .16]) nor for the path from relatedness to steps the following week ($\beta = .06$, 95% CI = [−.08, .22]).

Discussion

Variation in activity level

The results of the average weekly activity level among the patients indicated a relatively balanced distribution of participants from sedentary to highly active. Overall, 50% of the

patients could be characterised as active, with at least on average 9275 steps a day each week during the 12-week period. On average, the participants increased their activity level by in steps during the study period.

Subsequently, an institution that integrates PA as a part of treatment can facilitate for a higher activity level among a larger proportion of their patients than is normally observed among individuals with SMI (e.g. Burton et al., 2013; Schuch et al., 2017; Vancampfort et al., 2017). This finding is in line with previous research showing that when individuals with psychiatric diagnoses are offered adapted PA programs, they are as active as the normal population and sometimes more so (Farholm, et al., 2017b). However, even in an environment designed to promote PA several participants could be characterised as sedentary or low active, which is consistent with previous studies (Burton et al., 2013; Schuch et al., 2017; Vancampfort et al., 2017). This supports the need for a better understanding of how health care providers can facilitate increased PA behaviour (Glowacki et al., 2019). Nevertheless, the overview of PA levels for the current population gives a more nuanced picture of activity levels than that of the stereotypic sedentary psychiatric patient.

Dynamic interplay between psychological needs and PA

Overall, the results concerning the dynamic interplay between psychological need satisfaction and PA indicated positive credible cross-sectional associations between all three needs and PA-level. The cross-lagged effects were, however, small and not credible for all three needs in relation to PA-level. In total, these results support the established positive relation between basic psychological need satisfaction and PA-level, yet failed in finding any temporal effects between need satisfaction and PA-level. The current results regarding positive relations between need satisfaction and PA-level extend previous research within the SDT framework. A systematic review addressed the lack of research regarding the relation between the needs and PA, although some evidence has been found regarding the positive association between competence and PA (Farholm et al., 2017b; Teixeira et al., 2012). It is worth noting that the cross-sectional associations for all three needs in relation to PA on average throughout the 12-week period were credible and positive These findings indicate that need fulfilment is not only related to the internalisation process towards a more autonomous motivation (Ryan & Deci, 2017), it also seems to be directly associated with the PA behaviour among the patients.

Despite the clear tendency of associations between need fulfilment and PA, the result did not support any temporal effects between the constructs over time. From a methodological perspective, the autoregressive effects were high in all three models for both needs and PA (β ranged between .69 –.82), indicating that the T-1 measure of a variable explained most of the variance for the variable at T for both PA ($R^2 = .54$ for all three models) and all three needs (R^2 in the range of .57%–74%). Consequently, it might not be much variance left to explain for the variables T. Further, there might also be an applied explanation of the lack of temporal effects. Patients at this psychiatric ward are hospitalised due to their complex and severe mental illness and problematic addiction. Their well-being and functioning will most likely fluctuate from day to day, and from week-to-week. The expected temporal associations between need satisfaction and PA from one week to the next over a 12-week period may, therefore, not be linear,

and the time span between measurements may be too long. Although, the results on average indicated an increase in steps over the 12-week period. From an applied perspective, these results are interesting in relation to health care professionals working to facilitate both need satisfaction and PA (Glowacki et al., 2019; Sørensen et al., 2020). This is a challenging task with patients who experience frequent fluctuations in their struggles with complex symptoms and often difficult life situations. Within such a situation, it is necessary to acknowledge and value the relatively stable association between need satisfaction and activity level for each week. If health care providers can facilitate higher need satisfaction and PA for a current week, this is valuable, even if it does not lead to predictions for the next week. As such, when offering PA programs at psychiatric institutions, health care staff should tailor the PA program to fit the patients interest and preferences regarding type of activities (autonomy), individualise these activities so everyone can experience a sense of mastery (competence), and involve in the activities together with the patients (relatedness) (Sørensen et al., 2020; Teixeira et al., 2012). Thus, having health staff with competence regarding both PA in general and how to adapt PA to each individual's preferences and previous knowledge have shown to be crucial to be able to succeed in such contexts (Sørensen et al., 2020).

Limitations and future research

The study was conducted with participants having complex psychiatric conditions related to SMI and addiction. The design was relatively intensive over 12 weeks with weekly measurements. This may explain the relatively low participation rate (47.6%), which may be a limitation. Further, not having access to data of those participants who did not complete the data collection, both the power of the data was weakened, and the generalisability could be reduced. Although the sample size was relatively small, number of observations (140 observations) is deemed adequate for conducting dynamic p-technique analyses (Molenaar, 1985). Yet, future studies should aim to replicate the findings with larger sample sizes. Further, as it was voluntary for the patients to participate in the study, it is likely that the participants in the study were a self-selected skewed sample, where those with a positive attitude to PA and those more likely to be physically active participated. Also, Polar watches were used to measure PA behaviour objectively. Wrist worn watches were chosen as it would be easier for patients to wear daily during a 12-week period compared to hip-worn accelerometers. However, these watches indicate activity level to the participant, which could serve as an intervention in itself to increase the activity level (Dencker & Andersen, 2011). Last, we also suggest that investigation of non-linear relationships between the physical activity and the basic psychological needs is warranted.

Conclusions

The present study fills a gap in the literature about PA in psychiatric treatment, as it explores health behaviour among patients with dual diagnoses. The average activity level of the patients varied, yet, half of them could be characterised as active (10,000 steps a day) during this period. These indicate that integrated PA as part of treatment can facilitate a more active lifestyle. Furthermore, the findings indicated a positive

relation between psychological need satisfaction in PA and PA-level over time, and thereby extend the research within this field. Satisfaction of psychological needs does not only serve as an energy component for enhanced quality of motivation but is also directly associated with enhanced PA for this population. Thus, it is of importance that mental health clinics implement PA as a part of their treatment, and that the staff responsible for the activity have sufficient competence both in being PA instructors and in how to facilitate PA in a need supportive manner (Sørensen et al., 2020; Teixeira et al., 2012).

Disclosure statement

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ORCID

Andreas Ivarsson http://orcid.org/0000-0002-8987-5975

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