Evaluation of sports therapy in forensic psychiatry

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List of Publications

This cumulative dissertation is based on four peer-reviewed articles.

Review

Reimer, V., Ross T., & Kanning, M. (2022). Effects of sport therapy on psychosocial outcomes for forensic patients: A systematic literature review of evidence in mentally ill patients. *Sports Psychiatry, 1*, 107-15.
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Study 1

Reimer, V., Arway, F., Bulla, J., & Kanning, M. (2022). Promotion of Social Competence with the Sports-Therapeutic Volleyball Program GDivP in Forensic Psychiatry: a Pilot Study. *Deutsche Zeitschrift für Sportmedizin, 73*, 70-76.
https://doi.org/10.5960/dzsm.2021.518

Study 2

Reimer, V., & Kanning, M. (2023). Does Sports Therapy affect Momentary Affective States? Feasibility of Intensive Longitudinal Case Studies in Forensic Psychiatry. *Frontiers in Psychiatry, 14*, 1111602.
https://doi.org/10.3389/fpsyt.2023.1111602

Methodological discussion

Reimer, V., & Kanning, M. (2023). How far are N-of-1 studies suitable evaluation designs in forensic psychiatric sports therapy? A methodological discussion. *Sports Psychiatry,* 1-4.
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Abstract

Sports therapy offers a wide range of effects regarding physical, psychological and social functions and plays an important role in the treatment of forensic psychiatric patients. For instance, activating and improving physical abilities as well as improving cognitive and emotional functions. This potential of sports therapy is particularly interesting with regard to forensic psychiatry. However, specific research in forensic psychiatric sports therapy is scarce, causing a lack of evidence concerning effects and feasible study designs and data collection methods with this particular study sample aiming at improving well-being and psychological functioning. Sports therapy intervention studies can address these deficits.

This cumulative dissertation evaluates sports therapy in forensic psychiatry in order to present an initial effect analysis and to provide recommendations for future research in this area regarding appropriate study designs. It consists of two theoretical papers and two practical papers that were published in international journals.

First, a review of existing literature outlines a clear picture of the effects that sports therapy interventions have on psychosocial outcomes in patients with mental disorders relevant in the field of forensic psychiatry. The results illustrate promising effects of physical activity. However, of the 24 articles included in the systematic review, only one could be found that explicitly examined forensic psychiatric patients. This highlights the urgent need for specific research in the field of psychosocial performance resulting from sports therapy in forensic psychiatry.

An intervention is conducted to examine the extent to which social competent behavior in these patients can be promoted by a sports therapy program. The positive results show that social competent behavior is improved, however it remains unclear to what extent each patient benefits individually from the sports therapy intervention. Based on the averaged data, it is not possible to explain if some patients particularly benefit from sports therapy and others do not. In order to better understand individual effects of sports therapy, new methodological approaches to suit each patient should be applied. In addition, it may then be possible to conclude and predict whether there are similar or the same effects of sports therapy for certain patient characteristics.

Therefore, intensive considerations are made as to how these individual effects can be taken into account. Methodological considerations illustrate this new approach in form of case studies / N-of-1 studies. First, an intensive longitudinal case study design is tested, based on which, the N-of-1 study design is discussed methodologically by illustrating the possibilities and limitations of N-of-1 study designs. This results in specific recommendations for future research in forensic psychiatric sports therapy, with which this dissertation concludes.

Abstract (German)

Sporttherapie bietet ein breites Spektrum an Effekten in Bezug auf physische, psychische und soziale Funktionen und spielt eine wichtige Rolle bei der Behandlung forensisch psychiatrischer Patient*innen. Zum Beispiel die Aktivierung und Verbesserung körperlicher Fähigkeiten sowie die Verbesserung kognitiver und emotionaler Funktionen. Dieses Potenzial der Sporttherapie ist besonders im Hinblick auf die forensische Psychiatrie interessant. Es gibt jedoch nur wenige spezifische Forschungsarbeiten im Bereich der forensischen psychiatrischen Sporttherapie, so dass es an Belegen für die Effekte und an praktikablen Studiendesigns und Datenerhebungsmethoden für diese spezielle Stichprobe fehlt, die auf eine Verbesserung des Wohlbefindens und der psychischen Funktionsfähigkeit abzielt. Sporttherapeutische Interventionsstudien können diese Defizite beheben.

Diese kumulative Dissertation evaluiert die Sporttherapie in der forensischen Psychiatrie, um eine erste Wirkungsanalyse vorzulegen und Empfehlungen für die zukünftige Forschung in diesem Bereich hinsichtlich geeigneter Studiendesigns zu geben. Sie besteht aus zwei theoretischen und zwei praktischen Beiträgen, die in internationalen Fachzeitschriften veröffentlicht wurden.

Zunächst wird in einem Überblick über die vorhandene Literatur ein klares Bild der Effekte von sporttherapeutischen Interventionen auf psychosoziale Outcomes bei Patient*innen mit psychischen Störungen, die für den Bereich der forensischen Psychiatrie relevant sind, skizziert. Die Ergebnisse zeigen vielversprechende Wirkungen von körperlicher Aktivität. Von den 24 in den systematischen Review einbezogenen Artikeln konnte jedoch nur einer gefunden werden, der sich explizit mit Patient*innen der forensischen Psychiatrie befasst. Dies unterstreicht den dringenden Bedarf an spezifischer Forschung im Bereich der psychosozialen Leistungsfähigkeit als Folge von Sporttherapie in der forensischen Psychiatrie.
Anhand einer Intervention wird untersucht, inwieweit sozial kompetentes Verhalten bei diesen Patient*innen durch ein Sporttherapieprogramm gefördert werden kann. Die positiven Ergebnisse zeigen, dass sozial kompetentes Verhalten verbessert wird, jedoch bleibt unklar, inwieweit jede/r Patient*in individuell von der sporttherapeutischen Intervention profitiert. Auf der Grundlage der verallgemeinerten Ergebnisse lässt sich nicht erklären, ob einige Patient*innen besonders von der Sporttherapie profitieren und andere nicht. Um die individuellen Effekte der

Sporttherapie besser zu verstehen, sollten neue, auf die/den einzelne/n Patient*in zugeschnittene methodische Ansätze angewendet werden. Darüber hinaus können dann möglicherweise Rückschlüsse und Vorhersagen darüber getroffen werden, ob es bei bestimmten Patient*innenmerkmalen ähnliche oder gleiche Wirkungen der Sporttherapie gibt.

Es werden daher intensive Überlegungen angestellt, wie diese individuellen Effekte berücksichtigt werden können. Methodische Erwägungen veranschaulichen diesen neuen Ansatz in Form von Fallstudien / N-of-1-Studien. Zunächst wird ein intensives Längsschnitt Fallstudiendesign getestet, daraufhin wird ein N-of-1 Studiendesign methodisch diskutiert, indem die Möglichkeiten und Grenzen von N-of-1 Studiendesigns aufgezeigt werden.

Daraus ergeben sich konkrete Empfehlungen für die zukünftige Forschung in der forensisch psychiatrischen Sporttherapie, womit diese Dissertation abschließt.

1 Theoretical Background

1.1 Forensic Psychiatric Sports Therapy – State of the Art

In forensic psychiatry, mentally ill people are treated who have committed crimes due to their illness but who were, according to the law, not or only partially culpable at the time of the crime (Seifert, 2018). Psychiatric detention is primarily a security measure against dangerous offenders (Kammeier, 2018), has a preventive intention to avert possible future dangers (Kammeier, 2018) and reduces the hazardousness (Dönisch-Seidel, 2018). A large proportion of patients in forensic psychiatry were already in psychiatric hospitals prior to this placement and committed various criminal acts, including threats, physical assaults, and arson (Nedopil, 2018). Crimes leading to a stay in forensic psychiatry are violent, sexual or aggressive behaviors against others and are caused by mental disorders (Anckarsäter et al., 2009). In forensic psychiatry, the underlying disorders of the offenses are treated (Dönisch-Seidel, 2018). These are for instance, alcohol or drug addiction, personality disorders, schizophrenia or intelligence reduction (Schmid et al., 2016). A lack of motivation is often attributed to forensic patients (Schmidt-Quernheim, 2018). Moreover, these patients are characterized by high levels of impulsivity (Stellmacher & Häbler, 2016; Billen et al., 2019) and deficits in psychosocial behavior (Schmid et al., 2016). The end of the treatment is not definitively determined in psychiatric detention (Kammeier, 2018). In the case of discharge due to completion of the measure, forensic psychiatries must nevertheless consider a possible time to assess the degree of risk of reoffending in a timely manner, as well as begin to prepare for discharge into a structured living environment (Dönisch-Seidel, 2018).

In psychiatry, the involvement of the human body is particularly significant (Markser & Bär, 2015). Therapy in forensic psychiatry is multidisciplinary (Hoffmann et al., 2016; Schmidt-Quernheim, 2018), with sports therapy being one important component (Schmidt-Quernheim, 2018). Sports therapy provides a unique way for patients to encounter and discover their own bodies (Markser & Bär, 2015). Schüle & Deimel (1990) define sports therapy as a form of exercise therapy. Disturbed physical, psychological and social functions are compensated and regenerated, furthermore secondary damage is prevented, and healthy behavior is promoted (Schüle & Deimel, 1990). Pedagogical, psychological and sociotherapeutic procedures are

incorporated to improve health competence (Schüle & Deimel, 1990), which empowers people to increase control and responsibility over their health (Kickbusch et al., 2005). In addition to sports games and individual sports, the content of sports therapy includes relaxation methods and exercises for body awareness (Schmid et al., 2016). Exercise has positive effects on physical conditions such as hypertension, obesity, coronary heart disease, and diabetes mellitus, which occur as physical consequences of substance abuse and dependence (Freyer & Winter, 2015). Therefore, the use of physical activity as a therapeutical agent for people with addiction disorders is very meaningful (Freyer & Winter, 2015). In addition to activating and improving physical performance, sports therapy can help to improve cognitive performance (improving anhedonia) and emotional output, which in turn aims to relieve psychiatric symptomatology (Schmidt-Quernheim, 2018). Therefore, promoting traits that are low or absent in forensic psychiatric patients is intended (Schmidt-Quernheim, 2018): social behavior, anger management, conflict management, frustration tolerance, positive body experience, adherence to rules, self-confidence, and self-soothing. Therefore, resocialization is also a goal of sports therapy (Schuntermann, 2003). Another important objective of sports therapy is the reduction of anxiety as well as tense and depressive feelings (Schmidt-Quernheim, 2018; Bell et al., 2019; Ströhle, 2009; Carek et al., 2011) and stress (Broocks, 2013). Furthermore, regular physical exercise is associated with better emotional and affective states (Biddle & Mutrie, 2008; Schulz et al., 2012; Rebar et al., 2015; Netz et al., 2005) as well as perceived boredom (Wolff et al., 2021).

In addition to measurements and causal explanations, attempts must be made to understand mental phenomena on the basis of the experiences of individuals, which is why psychiatry needs generalizing and individualizing methods in order to do justice to the special circumstances (Markser & Bär, 2015). Besides quantitative research methods, qualitative methods, such as qualitative content analysis or hermeneutics, are also needed (Markser & Bär, 2015). Sports therapy requires the technical application of evidence-based knowledge, taking into account the clinical experience and the individuality of the patient (Markser & Bär, 2015).

This illustration highlights the potential that sports therapy offers, which is particularly interesting with regard to the very special population of forensic psychiatric patients. However, specific research in forensic psychiatric sports therapy is scarce. To date,

there is very little, if any, evidence on what effects sports therapy interventions have on this population, which patients with which diagnoses benefit most, or how studies need to be designed. There is a lack of evidence about effects, feasible study designs and data collection methods. This causes substantial blind spots in understanding forensic patients' mental health and their response to specific interventions that are targeted at improving mental health and psychological functioning. By employing intervention studies, this gap can be addressed. But first, a review of evidence available to date must be conducted. For this reason, the following chapter presents a published review (Reimer et al., 2022b) that examines the psychosocial effects of physical activity in patients with mental illness similar to those in forensic psychiatry.

1.2 Effects of Sports Therapy on Psychosocial Outcomes for Forensic Patients. A Systematic Review of Evidence in Mentally Ill Patients

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1.2.1 Abstract

Physical activity has gained importance in psychiatric and psychosomatic treatment schemes, but there is little knowledge on the use of physical activity for forensic rehabilitation, including psychosocial outcomes. A systematic review of the literature on PubMed and Livivo found only one study specifically addressed the effects of physical activity in forensic patients. Twenty-three studies reported on physical activity in the context of non-forensic patients suffering from mental illnesses similar to those commonly diagnosed in forensic patients. We summarize the effects of physical activity with respect to therapeutic objectives suggested by German sport therapists working with forensic patients. In forensic patients or patients suffering from mental illness typical of forensic patients, physical activity promotes social skills (4 studies), self-image, body experience, and personality growth (9 studies). Physical activity also helps to activate patients (12 studies), while reducing their tension and anger (1 study). Yet, there is a significant lack of specific scientific evidence as to whether sport therapy for forensic patients is effective in terms of the therapeutic objectives of this patient group. Future research must focus on longitudinal dose-effect outcome studies on forensic patients and should also concentrate on studies in the area of psychosis, personality disorders and addiction in relation to forensic sport therapeutic objectives.

Keywords: Physical activity, mental illness, personality, social skills, psychiatry

1.2.2 Introduction

Physical activity (PA) in the frame of sport therapy in psychiatry and psychosomatics is becoming increasingly important, as positive effects have been reported for mental illnesses and stress (Lukowski, 2018). Sport therapy is an exercise therapy intervention that particularly incorporates elements of educational, psychological, and socio-therapeutic practices (DVGS). Meta-analytic studies show positive effects of PA in patients suffering from psychiatric disorders relevant to the field of general psychiatry, including symptoms of schizophrenia (Rosenbaum et al., 2014; Soundy et al., 2014; Vancampfort et al., 2015a; Vancampfort et al., 2017; Vancampfort et al., 2015b), alcohol addiction (Hallgren et al., 2017), substance use disorders (Wang et al., 2014), and depression or depressive symptoms (Rosenbaum et al., 2014; Vancampfort et al., 2017; Knapen et al., 2015; Kvam et al., 2016; Rimer et al., 2012). Many of these disorders or psychiatric symptoms are also common in forensic psychiatric patients. In the context of forensic psychiatric treatment, PA seems to be associated with positive effects pertaining to social risk and other health related behaviors (Schmid et al., 2016).

There is plenty of general evidence on the effects of PA on mental illness, but little on psychosocial outcomes, or the treatment objectives of sports therapy. Yet, there is a lack of scientific evidence for its effectiveness in the overall structure of forensic psychiatric treatment, especially as far as psychosocial measures of change are concerned. Forensic psychiatric patients tend to be multi-morbid and to suffer from a multitude of symptoms pertaining to a wide range of mental illnesses as well as socio-psychological deficits associated with crime (Schmid et al., 2016). Mental disorders associated with offending and recidivism into criminal behavior include personality disorders, especially of the cluster B type (antisocial, borderline and narcissistic disorders, less frequently histrionic personality disorders), schizophrenic and other schizophreniform psychotic disorders. Psychosocial deficits typical of many forensic patients include little or no insight into their mental illnesses and related problems; antisocial attitudes and dysfunctional values and beliefs (e.g. my violence is not my fault, the others are out to get me, I am just defending myself); impulsivity, hostility, anger and poor social problem-solving skills. Apart from the fact that many forensic professionals believe in the positive effects of psychotherapeutic treatments and other specialized treatment programs for offenders on some psychosocial

problem areas of patients, especially impulsivity, hostility, anger and poor social problem-solving skills, little is known about the psychosocial effects of PA in forensic patients.

The purpose of this systematic review of current evidence is to summarize and structure the evidence available on psychosocial effects of PA in patients with mental disorders relevant in the field of forensic psychiatry (e.g. schizophrenia, personality disorders, intellectual disabilities, and addiction). To structure any psychosocial benefits or effects, we have used the sports therapeutic treatment goals as described by Ross et al. (2016) as the main criteria for psychosocial outcomes. These are (the development of) social skills, coping with conflict and frustration, the stabilization of personality, physical and psychological activation, correction of self-image, and changes in body experience.

Treatment effects for patients in forensic psychiatry

Forensic psychiatric treatment includes individual and group psychotherapy, as well as a number of complementary therapies, such as art, work, music, or PA. Evidence on the efficacy of complementary therapies is scarce, but there is a considerable body of research on psychotherapeutic approaches to the treatment of forensic patients (Konrad et al., 2019; Kröber et al., 2006; Müller & Nedopil, 2017). Yet, all therapeutic approaches have commonalities, as described in the literature on general psychotherapy. The five major mechanisms of therapeutic change are: therapeutic alliance, resource activation, problem actualization, motivation, and coping (Grawe, 2000; Grawe, 2004). PA as a building block of a general treatment strategy for mentally ill offenders is expected to produce controllable effects on rule-compliant and pro-social behavior (team spirit, fairness), aggression management, frustration tolerance, body perception and positive body experience, self-efficacy, self-esteem, self-calming, and reconciliation (Schmidt-Quernheim, 2018). While anxiety, tension and depressive moods can be reduced (Schmidt-Quernheim, 2018), there is little research on whether these treatment objectives can be attained with forensic patients.

Sport therapeutic objectives for forensic patients

Based on 55 expert interviews with sport therapists, specific sport therapeutic objectives for patients treated in German forensic psychiatric units were identified (Ross et al., 2016). The most important sport therapeutic treatment objectives for the treatment of patients under mental health detention orders according to section 63 of the German Penal Code[1] (Andrews et al., 1990) (mentally ill forensic patients) were: the development of social skills, coping with conflict and frustration, the stabilization of personality, and physical and psychological activation. For substance-dependent patients treated according to section 64 of the German Penal Code[2] (Andrews et al., 2011), two treatment objectives were identical, and two others emerged: development of social skills, coping with conflict and frustration, correction of self-image, and changes in body experience.

According to the sports therapists interviewed (Ross et al., 2016), the objectives of PA evolved as a result of offering structured PA to hundreds of forensic patients. Whether or not the developmental targets set forth by the therapists actually match the scientific evidence on the efficacy of PA in general, remains unclear. The same applies to the evidence on the efficacy of PA to change psychiatric symptoms and dangerous behaviors in forensic psychiatric patients. This review presents evidence on sports therapy as regards the six sport therapeutic objectives in forensic psychiatric patients.

[1] German Criminal Code, Section 63: Placement in psychiatric hospital. If a person has committed an unlawful act in a state of criminal irresponsibility or in a state of diminished responsibility, the court orders the person's placement in a psychiatric hospital if the overall evaluation of the offender and of the offense reveals that, due to the offender's condition, he or she represents a danger to the general public.

[2] German Criminal Code, Section 64: Placement in addiction treatment facility. If a person has an addiction to alcoholic drinks or other intoxicating substances and is convicted of an unlawful act which was committed in a state of intoxication or as a result of an addiction, court is, as a rule, to order placement in an addiction treatment facility if there is a danger that said person will in future commit serious unlawful acts as a consequence of this proclivity.

1.2.3 Methods

A comprehensive literature search following the PRISMA guidelines was carried out in the databases PubMed and Livivo. The inclusion criteria were: papers (1) published in English that (2) covered mentally ill persons, for whom interventions connecting to the psychosocial performance indicators laid out by forensic sport therapists were carried out. Excluded were articles not pertaining to the mental illness found in forensic psychiatry or those that did not relate to forensic sport therapeutic objectives.

To systematically evaluate the grade of evidence, we used the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework (Guyatt et al., 2011). Because this review is about effects regarding any kind of PA on different sport therapeutic objectives, randomized controlled studies or reviews were labeled first-grade evidence (1), prospective and longitudinal studies were labeled second-grade evidence (2), and cross-sectional studies were labeled third-grade evidence (3). The literature search was completed in March 2021 and the following search terms were applied:

- physical activity OR physical exercise OR sport therapy
- AND forensic psychiatry OR forensic patients OR offenders
- AND mental illness OR schizophrenia OR psychosis OR personality disorder OR addiction OR depression OR anxiety
- AND personality OR social skills OR empathy OR activation OR motivation OR self-image OR conflicts OR frustrations

1.2.4 Results

The analysis of the search terms resulted in 508 hits. After excluding inappropriate articles, only one study on forensic patients remained. Therefore, the forensic search terms (forensic psychiatry OR forensic patients OR offenders) were omitted in the second search. The second search resulted in a total of 21,448 hits. As a result, 24 publications were deemed thematically appropriate to represent the six forensic sport therapeutic objectives. These are described in more detail. Figure 1 contains a flowchart of the search routine. A summary of the classification of the grade of evidence is listed in Table 1. Eleven of twenty-four studies were rated grade 1, i.e. more than 50% of the studies were cross-sectional.

Figure 1. Study selection for systematic review of current evidence.

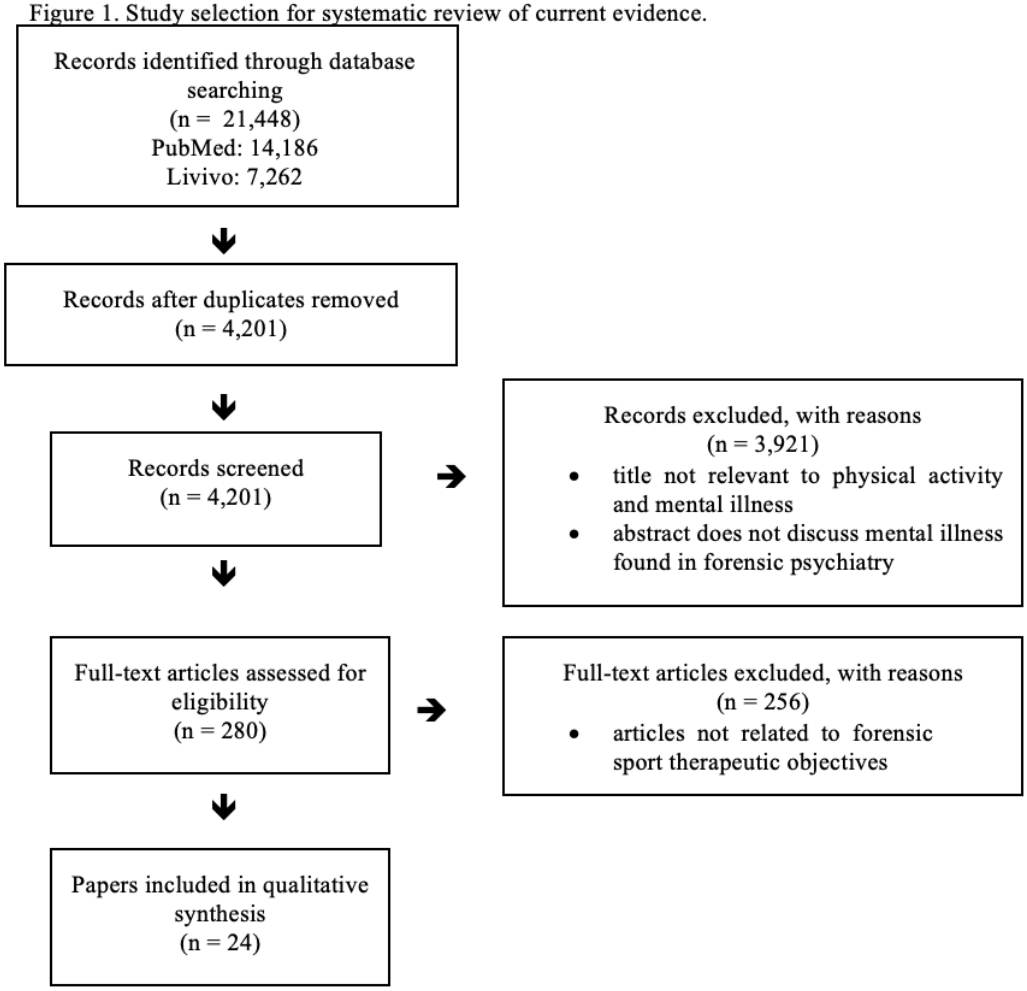

Table 1. Summary of the included publications.

Authors, year	Design	Main aim to investigate/assess/evaluate	Sport therapeutic objectives	Type of physical activity	Grade of evidence rating
Bartholomew et al., 2005	Randomized controlled trial	the effect of exercise on mood and well-being in depression	Dealing with conflicts or frustrations (reduction tension/anger)	30mins moderate-intensity treadmill exercise	1
Bassilios et al., 2014	Cross-sectional study	physical activity, attitudes and future intentions in patients with schizophrenia	Physical and psychological activation (social support)	Range: 10mins weight lifting to 10hrs of bike riding, single 15mins walk to 7.5hrs work-related PA (gym/weights, competitive sports, brisk/uphill walk, jogging or running, cycling, walking, dancing etc.)	3
Battaglia et al., 2013	Randomized controlled trial	the effect of soccer practice on schizophrenia	Social skills	Soccer training, twice a week 100-200mins, subdivided in 6 subphases	1
Biddle & Asare, 2011	Review	physical activity on depression, anxiety, self-esteem and cognitive functioning	Body experience, self-image, personality (physical self-perceptions, global self-esteem)	Aerobic and resistance training	1
Chapman et al., 2016	Cross-sectional study	preferences, motivators, barriers and attitudes for physical activity in general mental illness	Physical and psychological activation (social support of exercise instructor)	Walking, bushwalking, strength training, swimming, cycling	3
Costa et al., 2018	Cross-sectional study	autonomous motivation and quality of life for physical activity in schizophrenia	Physical and psychological activation	General physical activity	3

Danielsson et al., 2016	Randomized controlled trial	the effect of a physical therapy exercise intervention on depression	Body experience, self-image, personality (body-image, identity, self-esteem)	45-60mins endurance training, twice a week for 10 weeks, 2 single sessions followed by training in groups	1
Farholm & Sørensen, 2016	Systematic review	motivation for physical activity and exercise in severe mental illness	Physical and psychological activation (goal setting)	4 weekly hour-long small group sessions based on SCT; 16-week walking program 3 days/week with increasing duration; pedometer for a week; one session martial arts and one session stationary bicycling; 6-months o.a. group PA, 6 months individual and group sessions; 3 days/week x 6 or 12 weeks running or physiotraining; 30mins daily exercise starting with supervision; 3 days/week x 12 weeks individual exercise prescription with increasing intensity and duration; 3 days/week x 20 weeks supervised to unsupervised strength training; 3 days/week x 8 weeks strength training; 9 month individualized health promotion program 1/week health mentor and free fitness facilities access	1
Farholm, Sørensen & Halvari, 2017	Cross-sectional study	motivation for physical activity and quality of life in severe mental illness	Physical and psychological activation (suitable opportunities)	Physical activity defined as activities that make you breathe harder than normally, lasts at least 30mins and is conducted on most days of the week	3
Farholm, Sørensen, Halvari & Hynnekleiv, 2017	Cross-sectional study	motivation, competence, functioning and apathy in generally mental illness	Physical and psychological activation (empowering patients)	Accelerometer-equipped wristwatch	3

Firth et al., 2016	Systematic review and meta-analysis	motivation and barriers towards exercise in severe mental illness	Physical and psychological activation (motivate patients, social support, training program by experts)	General exercise	1
Fox, 1999	Narrative review and summary	the effect of physical activity on depression and anxiety	Body experience, self-image, personality (physical self-perceptions, global self-esteem)	Aerobic and resistance training	1
Gorczynski et al., 2018	Cross-sectional study	correlations between physical activity and negative symptoms in psychosis and diabetes	Self-image, personality (self-efficacy)	General physical activity	3
Hendryx et al., 2009	Cross-sectional study	social support, activities and recovery from serious mental illness	Physical and psychological activation (social support)	Walking, playing a sport, hiking and activities of daily living, leisure activities	3
Knapen et al., 2015	Review	the effect of exercise therapy on mental and physical health in major depression	Body experience, self-image, personality (body-image)	Exercise therapy: starting with and maintaining supervised exercise, follow-up after supervised exercise	1
Lee et al., 2018	Cross-sectional study	psychosocial factors associated with physical activity on psychosis	Self-image, personality (self-efficacy)	Regular physical activity	3
Mazyarkin et al., 2019	Pilot study	health benefits of a physical exercise program on chronical mental illness	Social skills (empathic ability)	Long-term (6 months) group-based exercise program versus short-term (3 months)	1

McCormick et al., 2009	Cross-sectional study	of social context and everyday physical activity in generally mental illness	Physical and psychological activation (social support)	Uniaxial accelerometer	3
Mo et al., 2016	Cross-sectional study	physical activity in general mental illness	Self-image, personality (self-esteem, self-efficacy); Physical and psychological activation	Moderate and vigorous exercise	3
Richardson et al., 2005	Review	the effect of physical activity on serious mental illness	Social skills (social withdrawal); Self-image (self-esteem, self-efficacy)	Physical activity (structured group programs, walking programs, accumulation of moderate-intensity activity)	1
Sørensen, 2006	Cross-sectional study	motivation for physical activity on generally mental illness	Physical and psychological activation (empowering patients)	Walking, running/bicycle, organized sport, housework, more activities	3
Uusher et al., 2007	Cross-sectional study	physical activity preferences and barriers in severe mental illness	Physical and psychological activation (social support)	Exercise at a facility/at home, walking, housework, DIY activities, cycling, gardening, dancing, individual sport, team sport	3
Vinci et al., 2015	Randomized controlled clinical trial	the effect of team play football on schizophrenia	Social skills (social relationships, general social functions)	Weekly soccer training for 9 months with round table discussion	1
Wynaden et al., 2012	Cross-sectional study	the effect of an exercise program on psychotic disorders	Self-image, personality (self-confidence, self-efficacy)	Lifestyle training program: regular physical training for 6 months	3

Social skills

Four studies reported positive effects of PA on social skills, social functions, and empathy of patients suffering from mental disorders (other than schizophrenia; n = 2) or schizophrenia (n = 2).

Social skills are cognitive, emotional, and motor behaviors that may lead to a long-term favorable relationship between people (Hinsch & Pfingsten, 2007). PA, walking programs, and an accumulation of moderate-intensity activity can counteract social withdrawal in patients with serious mental illness (Richardson et al., 2005). The empathic ability is significantly better in chronically mentally ill patients receiving long-term (up to six months) than short-term (up to three months) group-based PA (Mazyarkin et al., 2019). Soccer training sessions, which occur regularly and typically last for at least three months, improve the social skills of schizophrenic patients (Battaglia et al., 2013; Vinci et al., 2015). In one study, the intervention group was trained twice a week for 100 to 120 minutes over the course of 12 weeks, whereas the control group did not receive regular training during this period (Battaglia et al., 2013). The training units were subdivided into six subphases, including a “social phase” to promote “social interaction and competence” and a “feedback phase” to promote participants’ “self-worth and adaptive self-beliefs” (Battaglia et al., 2013). In addition to the enhancement of the physical parameters, there were improvements to the mental components of the intervention group, such as “role limitations caused by emotional problems, social functioning, vitality” and “mental health” (Battaglia et al., 2013). In the other study, weekly soccer training with only male schizophrenic subjects was conducted over the course of nine months, which consisted of both training and a game as well as a weekly round table discussion with a psychiatric operator (Vinci et al., 2015). The control group and the intervention group both continued to engage in their activities, such as carpentry and other work activities (Vinci et al., 2015). Compared to the control group, the intervention group showed significant psychopathological improvements, a reduction of negative symptoms, improvement of overall physical and mental health, enhanced self-awareness, and an improvement of social relationships and general social functions (Vinci et al., 2015).

Body experience, self-image and stabilization of personality

Nine articles investigating the effects of PA on body experience, self-image, and personality in patients suffering from mental disorder (n = 2), psychosis (n = 3), or depression (n = 4).

Generally, for serious mental illness, PA promotes self-esteem and self-efficacy (Richardson et al., 2005; Mo et al., 2016), meaning structured group programs (walking programs) and a lifestyle modification (30 minutes of moderate-intensity activity per day), with at least three 20- to 60-minute exercise sessions per week (Richardson et al., 2005). In patients with psychosis, PA may also have significant effects on self-efficacy (Gorczynski et al., 2018; Lee et al., 2018), depending on the frequency, duration and intensity of physical activity (Gorczynski et al., 2018). This has also been demonstrated in a lifestyle-training program conducted within the State Forensic Mental Health Service in Australia (Wynaden et al., 2012), where regular physical training was offered over the course of six months. The aforementioned positive effects included symptom management, an increase in overall fitness, and improvements to self-confidence and self-esteem (Wynaden et al., 2012). This was the only study directly related to forensic psychiatric outcomes (Wynaden et al., 2012). Obviously, there is a significant lack of studies linking the objectives and effects of PA to forensic psychiatric patients.

Aerobic and resistance training can improve physical self-perception and global self-esteem in individuals suffering from depression or anxiety (Biddle & Asare, 2011; Fox, 1999). PA in people with depression improves body image, strategies for coping with stress, quality of life, and independence in daily activities in older adults (Knapen et al., 2015; Danielsson et al., 2016). The intervention lasted 10 weeks and included 45-60 minutes of endurance training twice a week (Danielsson et al., 2016). The first two units were single sessions, followed by training in small groups of eight subjects each. Data was collected through interviews in which the patients' experiences were divided into four categories. The first category, “struggling toward your healthy self”, pertains to a patient’s sense of empowerment, and may help motivate patients to live a more actively, to experience pride and joy through PA, to get a feeling of being physically and psychologically sound, and to regain a healthy self-image and identity, and participate in (social) life. The second category, “challenging the resistance”, pertains to self-satisfaction after PA, as well as a boost of self-esteem. The third

category, “feeling more alive but not euphoric”, refers to the patients being more vigilant, gentle, mobile, and energetic after exercise. The patients reported good feelings as a result of experiencing their own bodies in motion. In addition, exercise raised their general mood. However, some patients reported that the movement intervention did not bring about the hoped-for euphoric feelings. The last category, “needing someone to be there for you” emphasizes the importance of the physical therapist as a source of support and motivation, helping the participants to overcome motivational lapses and keep up the training until the end.

Physical and psychological activation

12 publications were found that show the positive effects of PA on the activation of patients suffering from mental disorders (n = 9) or, specifically, schizophrenia (n = 3).

In patients suffering from mental disorders, lack of motivation, lack of self-determination, fatigue, illness etc. are associated with significantly lower levels of PA (Mo et al., 2016; Sørensen, 2006; Uusher et al., 2007). In order to help patients with severe mental illnesses to engage in PA, the sessions should match the patients’ abilities and (psychosocial) needs (Farholm et al., 2017). Measures that may help are structured training in a facility (Uusher et al., 2007), social support (Uusher et al., 2007; Chapman et al., 2016; Firth et al., 2016; Hendryx et al., 2009; McCormick et al., 2009), the support of an exercise instructor (Uusher et al., 2007; Chapman et al., 2016), the promotion of intrinsic and extrinsic motivation (empowering patients to control their training independently) (Sørensen, 2006; Costa et al., 2018; Farholm et al., 2017), motivational interviewing, and goal setting (Farholm et al., 2016). In addition to pursuing physiological goals, it is also recommended to make use of exercise programs that provide psychological support to patients (Firth et al., 2016) and promote interaction with others (Bassilios et al., 2014).

Coping with conflict and frustration

One study investigating the effect of PA on the ability to deal with tension and anger was identified among patients with depression.

In patients with major depressive disorders, a 30-minute moderate-intensity treadmill exercise (60-70% of maximum heart rate), paired with mood recording five minutes before the intervention, five minutes after, 30 minutes after, and 60 minutes after, was found to reduce psychological stress, depression, confusion, fatigue, tension, and anger (Bartholomew et al., 2005).

1.2.5 Discussion

Six treatment objectives (Ross et al., 2016) served to structure and summarize the effects of PA on patients undergoing forensic psychiatric treatment. To the best of our knowledge, this is the first review that examines therapeutic objectives as defined by sport therapists active in forensic psychiatric facilities. PA is meaningfully associated with the psychosocial effects of patients with severe mental illness, especially if PA is administered in a group format (group exercise). It is possible that individual, tailored sports programs may be effective for some patients, but little is known about the specific effects of individual compared to team sports programs, probably because individual training is much less commonly used in forensic practice than team or group training (individual training requires one therapist for one patient, whereas team programs can be implemented much more cost-effectively). In addition, group training programs contain a much stronger psychosocial skills component than individual ones. There is a wealth of studies linking PA to the promotion and development of social skills and the physical and psychological activation of the patient. There is some evidence that structured PA may be associated with correction of the self-image, change in body experience, and stabilization of personality, but additional studies are required. Surprisingly, no literature was found on learning to deal appropriately with conflicts or frustrations. From a clinical point of view, it is obvious that coping with conflict and frustration should be a cornerstone of all psychiatric treatment efforts, since conflict resolution and reducing psychological tension (between patients and between patients and

staff) is a daily routine within the wards. Clearly, this does not apply only to forensic psychiatric patients, but to all kinds of psychiatric patients.

Coping with conflict and frustration reflects a set of behaviors that can be conceived of as part of other treatment targets, i.e. the promotion of social skills (learning to deal with conflict and frustration are both social skills). Thus, conflict and frustration may be a subgroup within a larger set of behaviors referred to as social skills, which is why using these designations as the principal search terms for a literature review may not be sensitive. Furthermore, only one study involving forensic patients was found (Wynaden et al., 2012). Apparently, German forensic sport therapists focus more on the psychological outcomes of sport therapeutic activity than the physical outcomes. Based on this review, it seems that most treatment targets expressed by these professionals are backed by scientific evidence pertaining to the sport therapeutic treatment of psychosomatic and psychiatric patients in general, but not for forensic patients. Patients in general psychiatric treatment do not differ much from forensic patients in terms of the aforementioned (specific) mental disorders they suffer from. Therefore, PA could be effective for forensic psychiatric patients, too. To test this assumption, specific research on psychosocial performance of forensic psychiatric patients as a result of sport therapeutic intervention is needed.

Limitations

Cross-sectional studies showed that mentally ill patients may be highly motivated to participate in physical activities and that positive effects on various parameters of mental illness are likely as a result of PA. The problem is that cross-sectional studies do not show causal relationships between PA and mental outcomes. Yet, our point of view is that the results of the cross-sectional studies may be a good starting point for planning RCT-studies. Cross-sectional studies provide assumptions about possible associations between PA and sport therapeutic objectives in the field of mental health. These assumptions should be used to plan and conduct other types of studies more suitable to elucidate causal relationships between PA and mental outcomes in forensic patients. For this reason, the above-mentioned findings do not all refer to RCTs, but also to cross-sectional studies.

Conclusion

Sport therapeutic treatment goals for forensic patients are mainly directed at improving psychosocial performance. Yet, there is little scientific evidence suggesting that forensic patients benefit from PA in terms of acquiring psychosocial competencies. Based on relevant findings on (general) psychiatric patients suffering from the same mental disorders as forensic patients do, one may hypothesize that PA will be effective for forensic psychiatric patients, too. But currently, the evidence is missing and should be provided; otherwise, PA with forensic patients will continue to stand on shaky ground. Longitudinal dose-effect outcome studies on forensic patients, controlling for psychiatric diagnoses and index offences, should be designed and carried out.

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1.3 Research Question and Agenda

Chapters 1.1 and 1.2 illustrate very strongly that there is a considerable need for research regarding sports therapy evaluation in forensic psychiatry. Based on the published review (Reimer et al., 2022b), physical activity shows positive effects in psychiatric patients, but the results do not relate specifically to psychiatric patients in forensic settings. However, the publication suggests that the positive effects described could also apply to forensic psychiatric patients and strongly recommends that studies should be conducted with this clientele (Reimer et al., 2022b).

This dissertation aims to contribute to the evaluation of sports therapy in forensic psychiatry to address the research deficit described above. By first providing a review (Reimer et al., 2022b) of existing literature (Chapter 1.2) one gets a clear picture of what effects sports therapy interventions have on psychosocial outcomes. Subsequently, the thesis is divided into two major research areas. On the one hand, the main research question is to investigate *social competence* in forensic psychiatric sports therapy in a practical approach (Chapter 2). To this end an intervention study (Reimer et al., 2022a) to examine the extent to which *social competent behavior* in these patients can be promoted by a volleyball intervention was conducted and is reported in chapter 2.2. In the following, the methodological issues of this practical implementation are discussed (Chapter 2.3). On the other hand, new approaches how to evaluate in forensic psychiatric sports therapy, in the form of case studies / N-of-1 studies, are presented (Chapter 3.1). First, a study (Reimer & Kanning, 2023a) that investigated the extent to which case studies are a feasible study design in forensic psychiatric sports therapy is reported (Chapter 3.2). Subsequently, a published methodological discussion (Reimer & Kanning, 2023b) outlines the possibilities and limitations of an N-of-1 study design in forensic psychiatric sports therapy (Chapter 3.3). In summary, the results and findings of the described chapters are discussed (Chapter 4). The dissertation concludes with recommendations for future research (Chapter 5).

2 Social Competence in Forensic Psychiatric Sports Therapy

2.1 Practical Implementation

As the published review (Reimer et al., 2022b) clearly indicates, it is imperative to examine the sports therapeutic objectives according to Ross et al. (2016) in an intervention study. The focus in this chapter is on *social competence*. The rationale for choosing this sports therapeutic objective is due to the fact that the promotion of *social competence* addresses the aggressive, impulsive, and conflictual behaviors of forensic psychiatric patients (Ross et al., 2016; Broocks, 2013; Stellmacher & Häbler, 2016). For that reason, a pilot study (Reimer et al., 2022a) to check the extent to which *social competence* can be promoted in forensic psychiatric patients as part of a volleyball workshop is shown in chapter 2.2. This study (Reimer et al., 2022a) was conducted for the first time and therefore also discloses potential hurdles regarding the utilized study design.

2.2 Promotion of Social Competence with the Sports Therapeutic Volleyball Program GDivP in Forensic Psychiatry: a Pilot Study

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2.2.1 Abstract

In German forensic psychiatry, sports therapy denotes an accompanying therapeutic treatment, although evidence about specific psychometric and mental health outcomes is lacking. This article provides an important contribution to evidence-based sports therapy interventions. It focuses on one of the most important sports therapy goals for forensic patients: social competence. For this purpose, the intervention 'Group Dynamics in Volleyball Program' (GDivP) was developed, which included practice of three components of social competence: perspective taking, communication skills, and social responsibility. This study included a pre-post control group design. According to the results, GDivP improved all three of the components of social competence mentioned above. Further studies must determine how sustainable the positive changes are and to what extent the intervention can be transferred to other sports.

Keywords: sports therapy, group dynamics, perspective taking, communication skills, social responsibility.

2.2.2 Introduction

Numerous pieces of evidence support positive associations between sports therapy interventions and psychological and physical effects (Ashdown-Franks et al., 2020; Stellmacher & Häbler, 2016; Oertel-Knöchel & Hänsel, 2016). Sports therapy effects on global psychological constructs such as reduction of depressive symptomatology, etc., have previously been studied so far (Kandola et al., 2019; Kvam et al., 2016). Less focus was placed on specific therapy goals in forensic psychiatry. Furthermore, the practice of evaluating sports therapy effects in forensic psychiatry is still in its infancy (Ross et al., 2016), especially with regard to psychosocial effects (Schmid et al., 2016). The literature points to further research is needed to provide disease-specific therapy recommendations for each patient and to further differentiate sports therapy (Rahman et al., 2017). Four goals in sports therapy have been identified for this specific group of patients (Ross et al., 2016). One of these goals is 'promoting or building different components of social competences' (Ross et al., 2016). The following study analyzed the extent to which a special volleyball training titled 'Group Dynamics in Volleyball Program' (GDivP) improves different components of social competences in forensic patients. People who can adapt to social environmental conditions are described as socially competent (Kanning, 2002). The three basic areas of social competence in sports are perspective taking, communication skills, and social responsibility (Sygusch, 2007). The majority of offenders in forensic detention show relatively severe impairment in these skills (Billen et al., 2019; Byrne, 2020). Therefore, social competence is a relevant therapeutic goal in forensic sports therapy because it is associated with better aggression and impulse control and conflict resolution strategies (Ross et al., 2016; Broocks, 2013; Stellmacher & Häbler, 2016) and can be taught across different sports (Eime et al., 2013; Schmidt-Quernheim, 2018). Two RCTs show that weekly soccer training sessions have a positive effect on the social skills of schizophrenic patients when they train regularly over several months (Battaglia et al., 2013; Vinci et al., 2015). Only one study involving forensic patients was found in the literature evaluating the effects of an exercise program (Wynaden et al., 2012). One sport that is frequently played in forensic psychiatry is volleyball, as there is a wealth of experience in that field as well as interest and motivation among patients due to the weekly sports therapy sessions.

The combination in our study of a) a targeted sports intervention with specific exercises, b) the team sport volleyball and c) the clientele of forensic psychiatric patients, is a completely novel approach in the literature concerning how social competence can be trained during sports therapy.

Aim of the Study

The purpose of this study was to examine whether GDivP could be used to improve three components of socially competent behavior in forensic psychiatric patients: perspective taking, communication skills, and social responsibility. The intervention lasted four hours on each of three consecutive days and included specific sport tasks alternating with moderated group discussions on the topics of rules, communication and differences in performance (see Appendix 1).

Two hypotheses were be tested: Participation in the volleyball intervention would improve perspective-taking skills (H1a), communication skills (H1b), and social responsibility skills (H1c), whereas the control group would not improve (within-group changes). There would be a significant difference between the IG and the CG in perspective-taking skills (H2a), communication skills (H2b), and social responsibility skills (H2c) after the intervention, but not before the intervention (between-group differences).

2.2.3 Methods

Sample and Recruitment

German forensic psychiatric units house mentally ill forensic patients (Section 63 of the German Penal Code) (Ross et al., 2020) suffering from schizophrenia, personality disorder or intelligence reduction (Schmid et al., 2016) as well as substance-dependent patients (Section 64 of the German Penal Code) (Ross et al., 2020) who are dependent on alcohol or drugs (Schmid et al., 2016). In addition to the psychiatric clinical pictures and comorbidities, patients also exhibit

sociopsychological deficits (Schmid et al., 2016). Patients in both sections took part in the control group as well as in the intervention group.

In 2018 and 2019, data collection took place at the Center for Psychiatry Reichenau. Participation in GDivP was voluntary, but agreement to participate obligated patients to participate in each day of the project. The intervention group (IG) included 19 patients, but some subjects dropped out due to illness (n =3) or a lack of motivation (n = 1). Data from 15 subjects could be evaluated. The control group (CG) included 26 patients who performed regular sports therapy like the intervention group. One patient in the CG dropped out, so data from 25 patients could be evaluated. On average, subjects in the CG were *M* = 35.24 (*SD* = 11.53) years old (range: 21 to 59 years), and 84.6% (N = 22) were male. Subjects of the IG were *M* = 30.00 (*SD* = 7.93) years old (range: 20 to 55 years), and 83.3% (N = 15) were male. As the descriptive data shows, there were more male patients than female patients, which is representative of forensic patients (Nowara, 2003).

Procedure

The GDivP study used a pre-post control group design. Randomization of group membership was not possible. Patients in the IG participated in a three-day volleyball workshop (Friday-Sunday) for four hours each day, while patients in both the CG and the IG participated in volleyball games that took place during weekly sports therapy sessions. Assessment of social competence took place at the beginning and end of the intervention and, for the CG, during the ordinary weekly sports therapy sessions both before and after the GDivP weekend.

Survey Instruments

Demographics. Age, gender, height, weight, and body mass index (BMI) were recorded (patients' self-reports).

Social competence. To rate socially competent behavior via behavior observation, we developed an evaluation sheet (Appendix 2) assessing the three dimensions of social

competence in sports (Sygusch, 2007): perspective taking (PT), communication skills (CS), and social responsibility (SR). Since no scientifically based measurement instrument with possible application to sports could be found, we developed this evaluation sheet, which was based in terms of theory on Sygusch (2007). Two subcategories were assigned to each of the three components of social competence (Sygusch, 2007). A total of 13 items (PT=2, CS=4, SR=7) were specifically designed and formulated to apply to situations during the volleyball game in order to allow PT (e.g., recognition of and reaction to problems experienced by teammates/opponents in a game situation (movement/technique)), CS (e.g., the use of concise/brief instructions) and SR (e.g., adherence to agreed-upon rules) to be observed in a standardized way. The evaluation sheet contains a three-point Likert scale (coding 0-2). Subscores for each subcategory were added; thus, the maximum score differed per subscale (PT=4, CS=8, SR=14). To estimate the construct validity of our evaluation sheet, we correlated its data with relevant subscales of the Essen Resource Inventory (ERI) (Tagay et al., 2008) (social competence: 6 items) and the Inventory of Social Competences (ISC) (Kanning, 2009) (prosociality: 7 items; perspective taking: 6 items) of a subsample (N = 7). Due to the small sample size, we used Spearman's rho for correlation analysis and identified a coefficient of r = .81.

Intervention

The GDivP intervention schedule is presented in clear, chronological order in the appendix (Appendix 1). The volleyball intervention took place from Friday to Sunday. Over the course of the three-day volleyball weekend, patients were trained in three different components of social competence in sports: PT, CS and SR. The learning fields of 'rules' and 'recognizing and considering differences' were drawn from Balz (1998).'Communication skills' were trained by means of our own tasks, which were developed in accordance with Balz (1998).

Data Analysis

T tests for dependent samples were used to calculate the differences between the two time points measured (within-group changes), and t tests for independent samples were used to calculate the differences between both groups (between-group differences). The data was checked for t test assumptions. None of the assumptions were violated, except that the data were not normally distributed. Since linear models are typically understood to be robust against the violation of the normality assumption (Box, 1962; Knief & Forstmeier, 2021), the t test was still the statistical method of choice. To show changes between pre- and postintervention, we calculated a difference value (post value minus pre value) for each scale and group. We hypothesized that the volleyball intervention would improve *social competence* in the IG (H1a, H1b, H1c) but not in the CG and that the difference between the two groups would not be significant before the intervention (H2a, H2b, H2c), but would be significant after the intervention (Figure 2). To test the effectiveness of GDivP and to reduce the risk of type I errors, a Bonferroni correction was conducted.

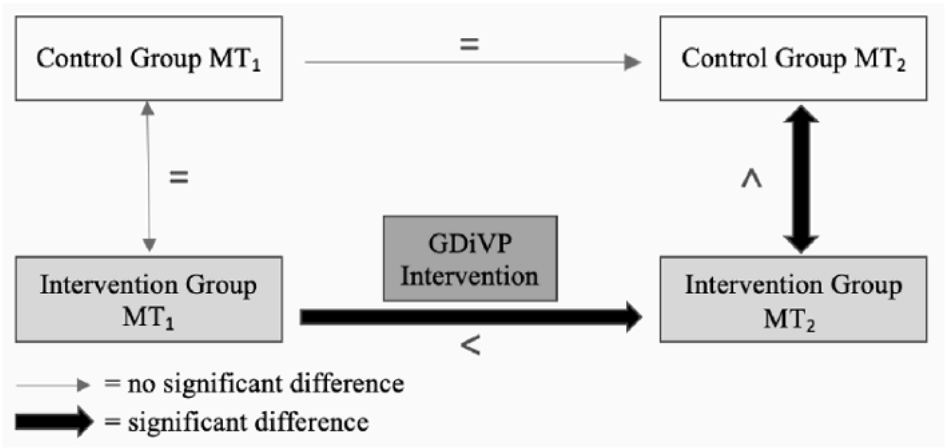

Figure 2: Pre-post control group design.

2.2.4 Results

Descriptive Results

All differences in values were positive, even though the increases were lower in the CG group, showing an increase on all scales (Table 2).

Table 2.

Values of the descriptive analysis at measurement times 1 and 2. pt=perspective taking; cs=communication skills; sr=social responsibility; cg=control group; ig=intervention group.

Variable	N_1	N_2	Min_1	Min_2	Max_1	Max_2	$Mean_1$ (SD)	$Mean_2$ (SD)	Difference
pt cg	25	25	0	0	1.5	2	.44 (.49)	.66 (.51)	.22
pt ig	18	15	0	0	1.5	2	.60 (.51)	1.10 (.60)	.50
cs cg	25	25	0	0	2	2	.73 (.65)	.79 (.61)	.06
cs ig	18	15	0	0.25	1.5	2	.57 (.46)	1.15 (.51)	.49
sr cg	25	25	0.43	0.57	1.71	2	1.13 (.35)	1.15 (.39)	.02
sr ig	18	15	0.29	0.29	1.43	2	.92 (.43)	1.50 (.53)	.61

Inferential Results

To test the hypotheses concerning of within-group changes (H1a, H1b, H1c), we calculated a t test for dependent samples. Each hypothesis has two predictions, one for the IG and one for the CG. For the between-group differences (H2a, H2b, H2c), we calculated a t test for independent samples. These hypotheses also have two predictions each, one for measurement time 1 (MT_1) and one for measurement time 2 (MT_2). Effect sizes were calculated with Cohen's d (Cohen, 1988).

H1: Within-Group Changes

As predicted, the mean value of the IG increased significantly from MT_1 to MT_2 on all scales: PT (H1a) ($t_{(14)}$ = -2.65, p = .019, d = 0.683), CS (H1b) ($t_{(14)}$ = -4.25, p = .001, d = 1.100) and SR (H1c) ($t_{(14)}$ = -3.66, p = .003, d = 0.946). However, the mean value of the CG had no significant change in CS ($t_{(24)}$ = -.88, p = .387, d = 0.176) and SR ($t_{(24)}$ = -.50, p = .618, d = 0.101). In contrast to our hypothesis, the mean value of the

CG increased significantly in PT ($t_{(24)}$ = -3.09, p = .005, d = 0.618). Therefore, five out of six predictions were confirmed (see Figure 2 for all results).

H2: Between-Group Differences

The second hypothesis also had six predictions, of which four were confirmed. In PT (H2a), the difference between the IG and CG before the intervention was not significant ($t_{(41)}$ = -1.47, p = .148, d = 0.317), as was the case for CS (H2b) ($t_{(41)}$ = .35, p = .725, d = 0.279). However, at MT_2, only PT showed a significant difference ($t_{(38)}$ = -2.45, p = .019, d = 0.754), while the difference in CS was not significant ($t_{(38)}$ = -1.92, p = .061, d = 0.609). In contrast to our hypothesis in SR (H2c), the difference between IG and CG was significant at both MT_1 ($t_{(41)}$ = 2.03, p = .049, d = 0.537) and MT_2 ($t_{(38)}$ = -2.42, p = .020, d = 0.745) (see Figure 3 for all results).

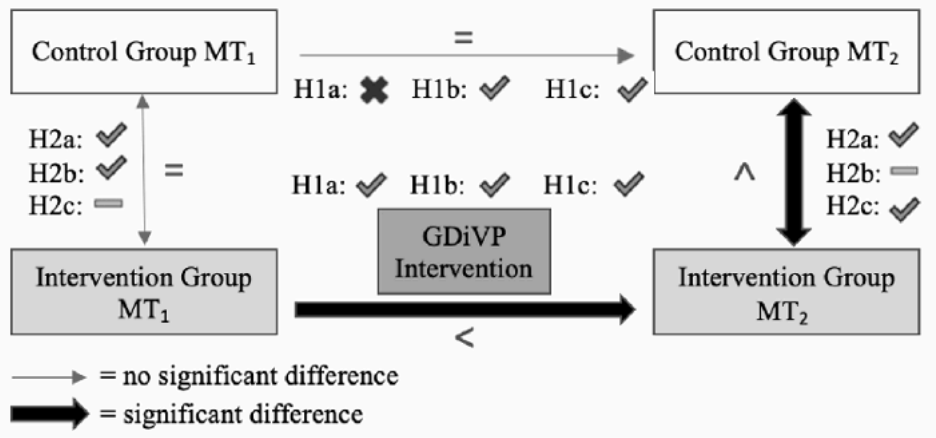

Figure 3. Testing the hypotheses. ✓: predictions confirmed; X: predictions not confirmed.

The results were controlled for age and gender.

The performance of a Bonferroni correction revealed that the effects of IG improving were stable for CS and SR but not for PT. Furthermore, the difference between IG and CG at MT_2 was not significant anymore.

2.2.5 Discussion

The present study investigated for the first time the effects of the 'Group Dynamics in Volleyball Program' (GDivP) on the improvement of social competence and thus on concrete therapy goals in forensic psychiatry.

The results show that GDivP can significantly improve the socially competent behavior of forensic psychiatric patients. Before the intervention, the CG and IG did not differ significantly in the three domains (PT, CS, SR) (H2a, H2b, H2c). The CG did not improve significantly from pre- to poststudy. The IG improved significantly from pre- to postintervention in all three domains (H1a, H1b, H1c). After the Bonferroni correction these effects were only present in CS and SR. In the case of H2c, the incorrect prediction even emphasizes the results more sharply, because the CG had a higher MV before the intervention. After the intervention, at MT_2, the IG had the higher MV. However, this is only the case in individual tests. For a general statement, the Bonferroni correction must be taken into account: there is no longer a significant difference between CG and IG (no difference to MT_2). The results of this study provide preliminary evidence that specific volleyball training might be effective in forensic patients with different psychiatric disorders, but those results have to be confirmed by further studies with larger sample sizes.

The results are consistent with findings of the National Youth Sport Program (NYSP) (20 days over 4 weeks), which included two hours of sport and one hour of enrichment activities (especially social competence training focusing on the development of problem solving and assertiveness skills) each day (Anderson-Butcher et al., 2013). There was one group of 193 participants who completed the pretest and posttest (Anderson-Butcher et al., 2013). Social competence improved due to the training, but not significantly (Anderson-Butcher et al., 2013). Social competence training is extremely important for youth and should therefore be integrated into sport activities (Anderson-Butcher et al., 2013). A two-months specific sports program (Sport Education Model (SEM)) was able to produce significant improvements in three components of social competence (social adjustment, prosocial behavior, perceived social efficacy) in adolescents (Luna et al., 2020). In this program, there was one control group (n = 44) and one experimental group (n = 69) for which a pretest and a posttest were conducted (Luna et al., 2020). The results of both studies show that socially competent behavior is very susceptible to training,

both in adolescents and in people with underlying psychiatric disorders. As these sports programs continue to evolve and become relevant to people working with these groups of individuals (Anderson-Butcher et al., 2013), further research in this area is needed. This volleyball study provides an initial approach in the context of the particular clientele of forensic psychiatric patients.

Volleyball was chosen as the team sport for several reasons. On the one hand, there are practical reasons for this decision. The patients are familiar with the game of volleyball from their weekly sports therapy sessions and thus also possess the necessary technical skills, and so a reasonably smooth flow of the volleyball game is guaranteed. The patients' interest in this sport was also greatest. In addition, the volleyball game was quite easy to monitor and observe. On this basis, the exercise blocks on the topics of perspective-taking, communication skills and social responsibility could be integrated very well. With regard to the sociopsychological deficits (Schmid et al., 2016) of forensic patients mentioned at the beginning, social skills from a sport scientific perspective (Sygusch, 2007) are an important topic in forensic psychiatry. We built our exercises by using the suitable learning fields of Balz (1998) as a guideline.

Feasibility of the Volleyball Intervention

The exercise unit 'establishing and adhering to rules' was easy to implement. The patients came up with a number of rules to which they adhered and which contributed to a better flow of the game (for example: no block on the serve, ball into the net or on the floor = point for opponent, at most 3 contacts with the ball, all body parts allowed, no pushing of the ball = only brief contact with the ball, hitting of the ball allowed on 1st contact). The adaptation of some rules was also able to be implemented well by the patients (2 ball contacts mandatory, whoever goes to the ball must say 'yes', ball must be received with both hands). The results of the exercise 'communication among one another' were mixed. The exercise that involved calling the name of the teammate who is being targeted worked very well, while the exercise that involved calling one's own name or naming the action before it is played was difficult for the patients to implement. The exercise 'recognize and consider differences' was also difficult for the patients to solve. The patients were good at

recognizing and discussing physical and psychosocial differences in performance beforehand, but during the volleyball game, it was consistently difficult to compensate for these differences because of position changes during to the game.

2.2.6 Limitations

The sample represents a very specific group, as the majority of forensic patients have several comorbidities in addition to the main diagnosis (schizophrenia, personality disorder, intelligence reduction, dependency on alcohol or drugs (Schmid et al., 2016)). Furthermore, only patients of the Center for Psychiatry Reichenau were recruited for the study, which is why the results can hardly be generalized.

With regard to the intervention, the recording of CS turned out to be relatively uncomplicated, whereas the items of PT and SR were difficult to record within the short observation time. Thus, it was a clear advantage to the observer that the patients were familiar from the weekly sports therapy.

However, the results of this study should not be considered as generally valid. The data collection was carried out by a sports therapist. This person knew the patients from weekly sports therapy. Thus, halo bias (the influence of previous information on subsequent evaluations) (Forgas & Laham, 2016) cannot be excluded. Furthermore, it should be noted that the observation sheet was self-developed, although it showed acceptable construct validity. The application of the observation sheet by those who are unfamiliar with it is therefore considered difficult and requires precise explanation with concrete examples for the 13 items. The Hawthorne effect (change in behavior as a response to observation and assessment) (Sedgwick & Greenwood, 2015) can be excluded since the participants of the study were only informed that the intervention is intended to promote 'better interaction' and not that concretely the three components of socially competent behavior are examined concretely. Due to the small number of subjects, we cannot investigate the moderating effect.

2.2.7 Implication

A relevant therapeutic goal in forensic inpatient treatment is to improve social competence. This study preliminary supports the finding that a sports therapy intervention can contribute significantly to this goal. Further studies must determine how sustainable the positive changes are and to what extent the intervention can be transferred to other sports (e.g., soccer or climbing).

2.2.8 Acknowledgments

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Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria, educational grants, participation in speaker's bureaus, membership, employment, consultancies, stock ownership, or other equity interest, expert testimony or patent-licensing arrangements) or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

2.2.9 Supplement

Table 3. Intervention procedure to promote social competence in forensic sports therapy during the volleyball weekend.

PATIENTEN-ID	STATION	DATUM		NICHT ZU-TREFFEND	TEILWEISE ZU-TREFFEND	EINDEUTIG ZU-TREFFEND
Perspektiven-übernahme	Erfassen von Perspektiven	Erkennt und reagiert auf Probleme von Mitspieler/Gegner in einer Spielsituation (Bewegung/Technik)	Volleyball: Angabe geht wiederholt nicht übers Feld | Reaktion: Vorschlag Feld zu verkürzen / näher ans Netz ran gehen / Ausführungstipps; Volleyball/Basketball/Fußball: A kannschlecht zuspielen/bewegen |Reaktion: B geht deswegen extra entgegen/versucht den Ball besonders gut zuzuspielen damit es einfacher fällt/Tippsgeben wie es besser / einfacher geht			
	Erfassen von Emotionen	Erfasst und reagiert auf Emotionen von M/G (Angst/ Resignation/Freude/ Unsicherheit/Wut)	Alle Mannschaftssportarten: Angst: Nach zu starker Angabe / Zuspiel schreckt der M/G vor dem Ball zurück | Reaktion: langsamer Ballwechsel; Resignation: Ein Spieler hat keine Lust (hört auf/..) |Reaktion: Andere zeigen Verständnis lassen ihn ausruhen; Freude: Ein M/G hat Spaß am Spiel und drückt diesen aus | Reaktion: Gegenseitig anfeuern / pushen; Unsicherheit: Hat Verständnisprobleme mit Regeln/Bewegung/Technik |Reaktion: Hilfe anbieten / Verständnis zeigen; Ärger/Wut: M/G schreit ist zornig/.. |Reaktion: Nachempfunden und nicht dafür rügen/fragen was los ist/..; …			
Kommunikations-fähigkeit	Rege Kommunikation	Spricht mit den anderen während des Spiels (Signale/Anweisungen)	Alle Mannschaftssportarten: Basketball/Fußball: langen oder kurzen Pass fordern/Rückpass zurufen/Laufwege kommunizieren/absprechen wer wen deckt/absprechen Taktik/Fehler verbessern….; Volleyball: höheres Zuspiel fordern/nicht so starke Angaben machen/absprechen; Taktik/Fehler verbessern/..			
		Bespricht das Spielgeschehen vor und nach dem Spiel mit M/G	Alle Mannschaftssportarten: Austauschen was gut/Schlecht funktioniert hat und was verbessert werden kann; Strategien für die nächste Runde besprechen			

	Beherrschen der Sportsprache	Nutzt knappe/kurze Anweisungen	Alle Mannschaftssportarten: Volleyball: wer nimmt den Ball: Ich/du & Zuspiele zäjhlen auf 3: 1/2/3 &…; Basketball/Fußball: lauf/hab ihn/Rebound/…			
		Nutzt nonverbale Sprache (Gestik/Mimik)	Alle Mannschaftssportarten: Volleyball: Zeichen für Zuspiel/bewegungsbreitere Position klar machen (anspielbar sein); Basketball/Fußball: Mit Hand/Fuß den Ball fordern/Blickkontakt halten/ gewünschte Laufrichtung/Wurfrichtung anzeigen			
Soziale Verantwortung	Zurückstellen eigener Interessen hinter gemeinsame Ziele	Übernimmt unbeliebte Positionen/Aufgaben für die M/G	Alle Mannschaftssportarten: Unbeliebte Position/Aufgabe für die Gruppe übernehmen: Ball holen/Torwart sein/Zuspieler sein/Angabe machen/Sportart ausüben trotz wenig Begeisterung/…			
		Bringt eigene Stärken für ein gelungenes Zusammenspiel ein	Die individuellen Fähigkeiten in bestimmten Situationen einsetzen um anderen zu helfen: Volleyball: Hohes Zuspiel zur Erleichterung der Annahme/leichte Angabenzu unsicherer Person/..; Basketball/Fußball: genaue/leichte Pässe zu unsicherer Person / besonders gut freilaufen um das Anspiel zu erleichtern/..			
		Regelmäßige Teilnahme (Trotz hoher Belastung)	Alle Mannschaftssportarten: Keine Kraft/Kondition mehr oder Wetter ist zu kalt/warm → macht trotzdem weiter für das Team			
		Akzeptiert Gruppenbeschlüsse	Wenn eine bestimmte Mannschaftsregel angepasst wird oder Mannschaften eingeteilt werden oder Positionen und Deckungsverhalten festgelegt wird | Reaktion: Akzeptanz und kein dagegenreden oder schimpfen			
	Zuverlässigkeit	Hält sich an die vereinbarten Regeln	Allgemeine und zusätzliche Spielregeln werden eingehalten			
		Hält sich an der ungeschriebenen Sport-Kodex (Fairness)	Handgeben/Abklatschen nach Foul oder Sieg/ nicht Ball wegschlagen oder grobe Fouls begehen			
		Führt Aufgaben aus, die im Team beschlossen werden	Ausführung der akzeptierten Gruppenbeschlüsse			

Table 4. Evaluation Sheet.

INTERVENTION TO PROMOTE SOCIAL COMPETENCE IN FORENSIC SPORTS THERAPY.

ERHEBUNGS-PHASE 1	*Freitag* -12:00-14:00 Uhr Anfangsspiel: PRE-BEOBACHTUNG - Mannschaften teilen Patienten selbst ein - Spiel nach Volleyballregeln wie in wöchentlichen Sportstunden **Ziel:** Miteinander spielen: -möglichst lange Ball in der Luft halten -möglichst viele Ballkontakte innerhalb einer Mannschaft
INTERVENTIONS-PHASE	-14:00-14:00 Uhr Pause -15:00-16:00 Uhr Erarbeitung eines besseren Zusammenspiels Teil 1: 1. Ziel: Regeln (klare Regeln wiederholen und zusätzliche bestimmen) **Inhalte:** Patienten an Aufstellung/Regeländerung beteiligen →Regeländerungen auf konkrete Probleme beziehen → Regeln/Regeländerungen bewerten → Regeln kontrollieren, Regelverstöße sanktioniere → Ursache für Regelverstöße ermitteln **Übungen:** → welche Hauptprobleme gibt es, welche Regelanpassungen sind → hilfreich? (kleineres Feld/Mindestanzahl an Zuspielen/Angaben/Netz → tiefer/Männer nicht im Angriff) → Regelanpassungen durchführen → welche Regeländerungen waren gut/schlecht? → sollen Regelverstöße sanktioniert werden? *Samstag* -12:00-13:30 Uhr Erarbeitung eines besseren Zusammenspiels Teil2: **2. Ziel:** Kommunikation untereinander (Verbesserung der Sportsprache und regen Kommunikation) **Übungen:** → vor Zuspiel eigenen Namen nennen → vor Zuspiel Namen des Mitspielers nennen → vor Zuspiel Aktion nennen → im Spiel nur Punkt, wenn Mannschaft untereinander kommuniziert, wer Ball annimmt -13:30-14:30 Uhr Pause -14:30-16:00 Uhr Turnier mit Anwendung des Erlernten *Sonntag* -12:00-13:00 Uhr Erarbeitung eines besseren Zusammenspiels Teil 3: **3. Ziel:** Unterschiede erkennen und berücksichtigen **Inhalte:** → Unterschiede aufklären: Anlagebedingte und umweltbedingte körperliche/psychosoziale Stärken jedes Einzelnen besprechen → auf Interessens-/Leistungsunterschiede eingehen und ausgleichen → Binnendifferenzierung herstellen **Übungen:** → Mannschaftstaktik nach Stärken besprechen lernen: z.B. wer lauf- und bewegungsstark ist, deckt größeren Feldabschnitt ab → neue Mannschaftstaktiken durchführen → bessere Mannschaft/Spieler dürfen nur baggern/pritschen → wer ist Ansager, Taktiker und übernimmt diese Rolle?
ERHEBUNGS-PHASE 2	-13:00-14:00 Uhr Pause -14:00-16:00 Uhr Abschlussspiel: POST-BEOBACHTUNG **Ziel:** Miteinander spielen: -möglichst lange Ball in der Luft halten -möglichst viele Ballkontakte innerhalb der Mannschaft

2.3 Interim Summary

It must be emphasized that with forensic psychiatric patients we have access to a very exclusive patient group. Through evaluation studies, we have the opportunity to contribute many new findings to the existing, yet very limited research. At the same time, it is also clear that existing barriers to research in forensic psychiatric sports therapy still remain to be uncovered.

Primarily, *social competence* was examined in a sports therapeutic setting of forensic psychiatry in this dissertation. The published GDivP study (Reimer et al., 2022a) offers us initial, unique and promising results (Chapter 2.2): The results suggest that specific training interventions offer added values to forensic psychiatric patients. At the same time, the publication displays that these results need to be confirmed by a larger study sample. In the published GDivP study, the intervention group consisted of 19 patients, although ultimately only data from 15 patients could be analyzed. This indicates that a *small sample size* is to be expected in forensic psychiatric sports therapy (Ross et al., 2016). Furthermore, it should be noted that in the published GDivP study (Reimer et al., 2022a) all patients were evaluated in one study group. Therefore, it is not apparent whether only individual patients may have benefited from the volleyball intervention while others did not. The *averaged results* do not provide any individual information (Zuidersma et al., 2020; Epstein & Dallery, 2022) and do not address the very high *heterogeneity* of forensic psychiatric patients (Ross et a., 2016).

Methodological issues now arise from the published GDivP study (Reimer et al., 2022a) that will be crucial to consider in any further research. It is hardly advisable to study this very special patient clientele in the context of traditional RCTs, since important individual aspects are disregarded (Rizvi & Nock, 2008). It is clear, that new considerations must be made as to what possibilities there are to highlight the individual patients, in order to obtain precise statements about the extent to which sports therapy interventions have effects.

3 New Horizons in Forensic Psychiatric Sports Therapy

3.1 Methodological Considerations

After pointing out the theoretical basis and the urgent need for research (Chapter 1), the published review (Reimer et al., 2022b) (Chapter 1.2) shows that physical activity could have positive effects specifically on forensic psychiatric patients and that evaluation studies urgently need to be conducted in this research field. The published GDivP study (Reimer et al., 2022a) was a first step in this direction and provides promising results (Chapter 2.2). However, it became clear that challenges such as the *small sample size*, the *averaged results* and the disregard of the *heterogeneity* of this particular patient group must be taken into consideration (Chapter 2.3).

According to the methodological issues described in the previous chapter 2.3, it becomes apparent that there is an urgent need to choose a study design that focuses on the individual patient to counteract the aspects *heterogeneity* and *low sample size* (Ross et al., 2016) that are omnipresent in forensic psychiatric sports therapy. One possibility is the case study / N-of-1 study design which is described in detail in the following chapters. The individual patient is the center of attention in this study design (Marwick et al., 2018). First, a pilot study (Reimer & Kanning, 2023a) to examine whether an intensive longitudinal case study design is feasible in forensic psychiatric sports therapy by collecting data on momentary affective states is tested (Chapter 3.2). Subsequently, the possibilities and limitations of this study design are discussed methodically (Reimer & Kanning, 2023b) (Chapter 3.3).

3.2 Does Sports Therapy affect Momentary Affective States? Feasibility of Intensive Longitudinal Case Studies in Forensic Psychiatry.

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3.2.1 Abstract

Physical exercise interventions improve quality of life in people with mental disorders and improve abstinence and cravings in substance use disorders patients in both the short and long term. In people with mental illness, physical exercise interventions significantly reduce psychiatric symptoms of schizophrenia and symptoms of anxiety. For forensic psychiatry, there is little empirical evidence supporting mental health-enhancing effects of physical exercise interventions. Interventional studies in forensic psychiatry deal mainly with three problems: heterogeneity of the individuals, a small sample size and a low compliance rate. Intensive longitudinal case studies could be a suitable approach to address these methodological challenges in forensic psychiatry. This study uses an intensive longitudinal design to determine whether forensic psychiatric patients are content to complete several data assessments per day over the course of several weeks. The feasibility of this approach is operationalized by the compliance rate. Additionally, single case studies examine the effects of sports therapy (ST) on momentary affective states (energetic arousal, valence, calmness). The results of these case studies reveal one aspect of feasibility and offer insights into the effects of forensic psychiatric ST on the affective states among patients with different conditions. The patients' momentary affective states were recorded before (PRE), after (POST) and one hour after (FoUp1h) ST by questionnaires. Ten individuals (*M*age = 31.7, *SD* = 11.94; 60% male) participated in the study. A total of 130 questionnaires were completed. To perform the single case studies, data of three patients were considered. Repeated-measures ANOVA was

performed for the individual affective states to test for main effects of ST. Due to the results, ST has no significant effect on none of the three affect dimensions. However, effect sizes varied between small to medium (energetic arousal: $\eta^2 = 0.01$, $\eta^2 = 0.07$, $\eta^2 = 0.06$; valence: $\eta^2 = 0.07$; calmness: $\eta^2 = 0.02$) in the three patients. Intensive longitudinal case studies are a possible approach to address heterogeneity and the low sample size. The low compliance rate in this study reveals that the study design needs to be optimized for future studies.

Keywords: intensive longitudinal case studies, sports therapy, forensic psychiatry, affective states, energetic arousal, valence, calmness.

3.2.2 Introduction

There is a considerable amount of evidence showing that physical exercise interventions improve quality of life in people with mental disorders and improve abstinence and cravings in substance use disorder patients in both the short and long term (Giménez-Meseguer et al., 2020). In people with mental illness, physical exercise interventions significantly reduce psychiatric symptoms of schizophrenia (Firth et al., 2015) and symptoms of anxiety (Gordon et al., 2017). A systematic review and meta-analysis investigating physical activity interventions in people with mental illness showed small to large short term effects of physical activity on symptoms of mental illness (Rosenbaum et al., 2014). However, for forensic psychiatry, there is little empirical evidence supporting the effects of physical exercise interventions. Conducting research studies to investigate the effects of sports therapy (ST) on forensic psychiatric patients is challenging due to various reasons (Ross et al., 2016). Typical barriers include a low sample size in ST sessions, as patients from different wards have to train in separate groups and cannot be put into one group (Ross et al., 2016). Additional challenges include low compliance rates and high heterogeneity within psychiatric diagnoses (Ross et al., 2016). Furthermore, there are sociopsychological deficits associated with the crime that are specific to forensic psychiatry (Schmid et al., 2016). Forensic patients suffer from poor physical conditions and a high variability and fluctuation in momentary affective states, which could be an explanation for the low sample size and the low compliance rate. (Ross et al., 2016). In forensic patients there are only a few patients

who (can) participate in a study due to symptomatology and heterogeneity, baseline restrictions, nonparticipation etc. (Ross et al., 2016), thereby causing variations and fluctuations in behavior and well-being (Ross et al., 2016). On average, a ST group in forensic psychiatry consists of a small number of participants (5-10) that fluctuates in each unit (Ross et al., 2016). Regarding intervention studies, the average compliance rate in forensic psychiatric studies is 53% (Wynaden et al., 2012), which is lower than the rate (63%) in people with serious psychiatric disabilities (Skrinar et al., 2005). The high heterogeneity in psychiatric diagnoses is due to a combination of several factors causing a mental illness such as individual characteristics and experiences, social influences, when certain events took place or how the person developed (Cicchetti & Rogosch, 1996). Challenges such as motivation (Stellmacher & Häbler, 2016) and impulsivity (Stellmacher & Häbler, 2016; Billen et al., 2019) are additional factors that contribute to a low compliance rate and generally a low number of participants (Wynaden et al., 2012). These hurdles initially make it difficult to conduct studies that can then provide information on forensic patients' responses to specific ST interventions that are aimed at improving well-being, quality of life and psychological functioning.

To address these challenges in forensic psychiatric research, using single case studies could be used as a methodological solution. Single case studies offer a useful method for evaluating data from patients who experience the heterogeneity of psychiatric disorders (Lillie et al., 2011; Marwick et al., 2018), as individual variability as well as valuable information about the individual treatment progress can be lost in a between-group design (Rizvi & Nock, 2008). Intensive longitudinal case studies offer the ability to examine participants over a longer period of time (e.g., several weeks) and several times a day in their natural context (Venetz & Zurbriggen, 2015). Therefore, a low sample size is accounted for in such designs. These types of studies require a higher amount of effort for researchers and participants, and it is unclear whether or to what extent this is tolerated by forensic patients due to motivational problems and impulsivity (Ross et al., 2016; Schmid et al., 2016; Wynaden et al., 2012) and if the low compliance rate can be addressed. Data collection at multiple measurement timepoints is used to generate a sufficient amount of data per patient. The terms "single case study" and "N-of-1" study are used synonymously (Lillie et al., 2011; Kwasnicka et al., 2019; McDonald & Nikles, 2021). Throughout this article, the term single case study is used. A clear distinction should

be drawn to a case report (McDonald & Nikles, 2021). A case report is purely descriptive, whereas a single case study demonstrates rigorous methods for the study design and data analysis using visual and statistical methods whenever possible (McDonald & Nikles, 2021). A single case study design is a common study design in health care (McDonald & Nikles, 2021; Trompetter et al., 2019; Cha et al., 2022), e.g., in psychiatric disorders, such as schizophrenia (Marwick et al., 2018; Pioch et al., 2021; Mehta et al., 2018). This design addresses intraindividual differences (Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022) and contributes to individualized medicine (Lillie et al., 2011; Wolters et al., 2022). The authors of a study in forensic psychiatry show, within a randomized controlled trial, that the addition of a single-case experimental design enables a more intense investigation of specific patients (Fielenbach et al., 2017). They report the advantage of the single case study designs in the form of closer monitoring of each patient and receiving valuable information about each patient (Fielenbach et al., 2019) that is more in-depth (Fielenbach et al., 2017). These findings suggest that single case studies in forensic psychiatry could be used to address heterogeneity.

In the field of forensic psychiatry, case study designs have been implemented in the form of neurofeedback training (Fielenbach et al., 2019) or music therapy (Prioch et al., 2021), but none have specifically examined the effect of ST. This study used an intensive longitudinal design to determine whether forensic psychiatric patients are content to complete several data assessments per day over the course of several weeks. The feasibility of this approach was operationalized by the compliance rate. Additionally, single case studies were performed to examine the effects of ST on momentary affective states (energetic arousal, valence, calmness). To the best of our knowledge, this is the first study in forensic psychiatry to evaluate the feasibility of an intensive longitudinal case study design. Furthermore, the results of these case studies reflect one aspect of feasibility and offer insights into the effects of forensic psychiatric ST on the affective states among patients with different conditions.

3.2.3 Methods

Sample and recruitment

Data were collected in 2021 at the Center for Psychiatry Reichenau. Approximately 100 patients are accommodated there and distributed across four forensic wards. People are referred to this center if their offense was specifically related to the use of intoxicating substances or mental illness (Schmid et al., 2016). The total length of detention varies across individuals but ranges from a minimum of two years to multiple years (Schmid et al., 2016). Participation in the study was voluntary and patients committed to submitting regular study data on days with ST (twice a week). The ST intervention represented the regularly occurring therapy and was firmly integrated at the Center for Psychiatry Reichenau. The repeated recording of the momentary affective states did not represent a psychological intervention. Prior to study inclusion, each subject signed an informed consent form. In total, 10 individuals participated in the study. The patients' symptomatology included either paranoid schizophrenia, schizoaffective disorder (manic or mixed type), bipolar affective disorder (current episode manic without psychotic features), or mixed and other personality disorders or hyperkinetic conduct (Table 5). Participants received an organized bike tour as an incentive for participating in the study.

Table 5. Patient characteristics.

patient	sex	diagnosis ICD-10	data points total	data points PRE	data points POST	data points FoUp1h
1*	m	F20.0 Paranoid schizophrenia	27	10	10	7
2*	m	F20.0 Paranoid schizophrenia	29	10	10	9
3	f	F61 Mixed and other personality disorders	5	2	2	1
4	m	F20.0 Paranoid schizophrenia	11	4	4	3
5	m	F25.0 Schizoaffective disorder, manic type	12	5	5	2
6	f	F20.0 Paranoid schizophrenia	9	3	3	3
7	m	F90.1 Hyperkinetic conduct disorder	11	5	5	1
8	m	F20.0 Paranoid schizophrenia	0	0	0	0
9	f	F25.2 Schizoaffective disorder, mixed type	7	3	3	1
10*	f	F31.1 Bipolar affective disorder, current episode manic without psychotic features	19	8	8	3

*patients included for single case analyses

Procedure

Questionnaires to assess demographic details were completed before the first session of ST. Over a period of four weeks, affective state questionnaires were completed before ST (PRE), after ST (POST) and one hour after ST (FoUp1h). For the FoUp1h assessment timepoint, the sport therapist searched and contacted every patient in the facility.

Measurements

Demographics. Age and gender were self-reported and assessed with a paper and pencil questionnaire.

Momentary affective states. Self-report was used to assess patients' momentary affective states. For this purpose, the short scale by Wilhelm & Schoebi (2007) was used (see Appendix 1). This short scale is appropriate to minimize the effort for the patients. This instrument is validated and suitable for ambulatory assessment studies. The within-person reliability (energetic arousal: .77, valence: .70, calmness: .77) as well as the between-person reliability (energetic arousal: .90, valence: .92, calmness: .90) was acceptable (Wilhelm & Schoebi, 2007). Three bipolar affect dimensions (energetic arousal, valence, calmness) were measured by six items that assess the intensity of each affect dimension: energetic arousal (tired vs. awake, without energy vs. full of energy), valence (unwell vs. well, discontent vs. content) and calmness (relaxed vs. tense, calm vs. agitated). Responses were given on a 6-point Likert response scale.

Intervention

All 60-minute ST sessions followed exactly the same structure and the units were comparable in procedure, duration and intensity. Patients in this study participated in two different ST groups. The main intended effects of ST are to increase physical fitness, promote social skills in group sports, and contribute to a solid daily structure (Schmid et al., 2016). First, there was a warm-up phase that focused on circulation activation and technique practice. In the main phase, patients performed different group sport activities together (e.g., volleyball, soccer, tennis or table tennis). The intensity of the activity was structured in such a way that it was perceived as hard by the individuals (Borg, 1982). Furthermore, ST included technical elements (throwing and passing techniques, running routes, team formations etc.). The ST session ended with a collective cool-down, which was followed by a reflection phase in which the group discussed what went well during the session and what could be improved. Data collection took place in June and July 2021 at the Center for Psychiatry Reichenau.

Data analysis

Intensive longitudinal single case analyses were conducted to estimate whether forensic patients were content to complete several data assessments per day over the course of several weeks, with the feasibility being operationalized by the compliance rate (percentage of completed questionnaires). The longitudinal single case analyses were also performed to address the methodological challenge of heterogeneity. In addition, differences between the three measurement timepoints (PRE, POST, FoUp1h) for each affect dimension (energetic arousal, valence, calmness) were examined. To analyze within-subject changes and to describe in more detail how ST affected momentary affective states, a one-way repeated measures ANOVA was performed for the individual affective states. The ANOVA estimated if there were significant differences between the three measurement timepoints separately for each affect dimension. The weekly study sessions of ST as well as the factor time acted as independent variables, and the momentary affective states served as dependent variables.

Data were analyzed in RStudio with the corresponding describeBy() function from the psych package (Revelle, 2023) (alpha level $p<0.05$). For ANOVA, the aov() function of the afex package (Singmann et al., 2023) was used. The effect sizes were calculated using the eta_squared() function from the effectsize package (Ben-Shachar et al., 2023).

The requirements for ANOVA are the normal distribution of the data and variance homogeneity (Kim & Cribbie, 2018), which, as expected, was partially present in the dataset of this study. Nevertheless, repeated-measures ANOVA was conducted to give a certain trend recommendation.

3.2.4 Results

Descriptive results

A total of 130 questionnaires were completed (PRE: 50, POST: 50, FoUp1h: 30) by the ten patients (*M*age = 31.7, *SD* = 11.94; 60% male). Table 1 provides an overview of the data points provided by each patient (Table 1). The scores on the three affect dimensions were as follows (between-person distribution): energetic arousal, *M*=4.6 (*SD*=1.1; min=1, max=6); valence, *M*=4.6 (*SD*=1.47; min=1, max=6); calmness, *M*=4.9 (*SD*=1.14; min=1, max=6).

Single-case analyses

Patients 3 and 4 dropped out of the study after 10 and 14 days, respectively. Patient 8 did not participate in a single intervention measurement timepoint and consequently could not provide any conclusions about the effectiveness of ST. Due to the amount of missing data (≥40%), patients 5, 6, 7 and 9 were also excluded from the descriptive presentation of the results, as their incomplete data could not provide any conclusions about the effectiveness of ST. Therefore, a statistical presentation of the results of patient 1 (PRE: N=10, POST: N=10, FoUp1h: N=7), patient 2 (PRE: N=10, POST: N=10, FoUp1h: N=9) and patient 10 (PRE: N=8, POST: N=8, FoUp1h: N=3) were included for analyses (compliance rate: >63%). The effect size is an important finding to report, as a *p* value only indicates the presence of an effect, but does not indicate the size of the effect (Sullivan & Feinn, 2012). Effect sizes, unlike significance tests, are not dependent on sample size, but a significance test does (Sullivan & Feinn, 2012). When describing the effect sizes, the following values are considered: η^2 = 0.01 (small effect), η^2 = 0.06 (medium effect) and η^2 = 0.14 (large effect) (Cohen, 1988).

Patient 1

In patient 1 (Figure 1), our analyses showed a difference between the three measurement timepoints for energetic arousal, with the median score increasing from 4.5 (PRE) to 5.0 (POST) l. The valence scores increased from 2.5 (PRE) to 3.75 (POST), and the calmness scores increased from 5.5 (PRE) to 5.75 (POST). This indicates that patient 1 felt more energized, more comfortable and less restless immediately after ST. The median energetic arousal score was stable at FoUp1h (5.0), while the median scores on valence (3.5) and calmness (5.5) decreased at follow-up.

Small effect sizes were observed for energetic arousal (η^2 = 0.01) and calmness (η^2 = 0.02), while no effect was observed for valence (η^2 = 0.0041).

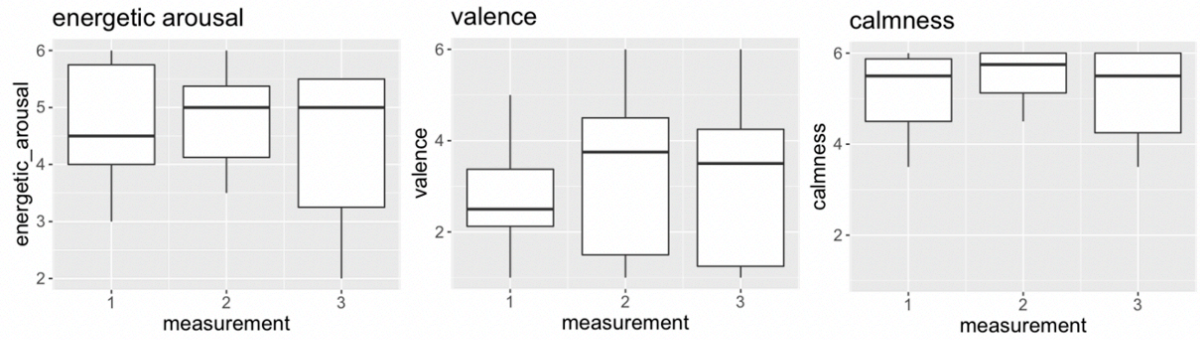

Figure 4. The indicated values (1-6) of the dimensions energetic arousal, valence and calmness for measurement timepoint 1 (PRE), measurement timepoint 2 (POST) and measurement timepoint 3 (FoUp1h) for patient 1. The boxplots display the median and the 2nd and 3rd quartile.

Patient 2

In patient 2 (Figure 2), our analyses showed differences in affective dimensions between the three measurement timepoints, with the median energetic arousal score increasing from 5.0 (PRE) to 5.5 (POST), the median valence score increasing from 5.75 (PRE) to 6.0 (POST), and the median calmness score increasing from 5.5 (PRE) to 6.0 (POST). This indicates that patient 2 felt more energized, more comfortable and less restless immediately after ST. The scores at FoUp1h were stable for valence (6.0) and in calmness (6.0), while the median energetic arousal score decreased at follow-up (5.0).

Medium effect sizes were observed for energetic arousal (η^2 = 0.07) and valence (η^2 = 0.07), but no effect was observed for calmness (η^2 = 0.000572).

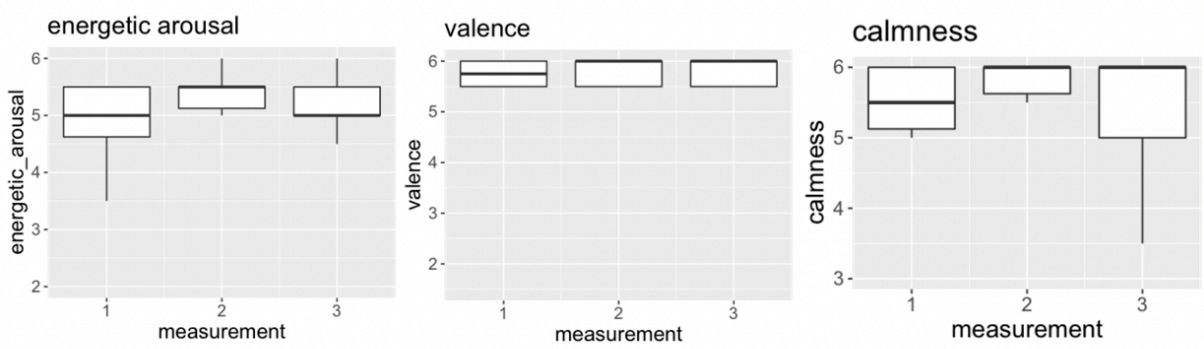

Figure 5. The indicated values (1-6) of the dimensions energetic arousal, valence and calmness for measurement timepoint 1 (PRE), measurement timepoint 2 (POST) and measurement timepoint 3 (FoUp1h) for patient 2. The boxplots display the median and the 2nd and 3rd quartile.

Patient 10

In patient 10 (Figure 3), our analyses showed a difference in calmness between the three measurement timepoints, with the median score increasing from 5.5 (PRE) to 5.75 (POST) and the decreasing to 5.5 again at FoUp1h. For energetic arousal and valence, the median score did not change between the PRE to POST timepoints (5.5 and 5.75, respectively). Furthermore, the median scores for energetic arousal (5.5) and valence (6.0) increased at FoUp1h.

A medium effect size was observed for energetic arousal ($\eta^2 = 0.06$), but no effects were observed for valence ($\eta^2 = 0.00133$) and calmness ($\eta^2 = 0.00217$).

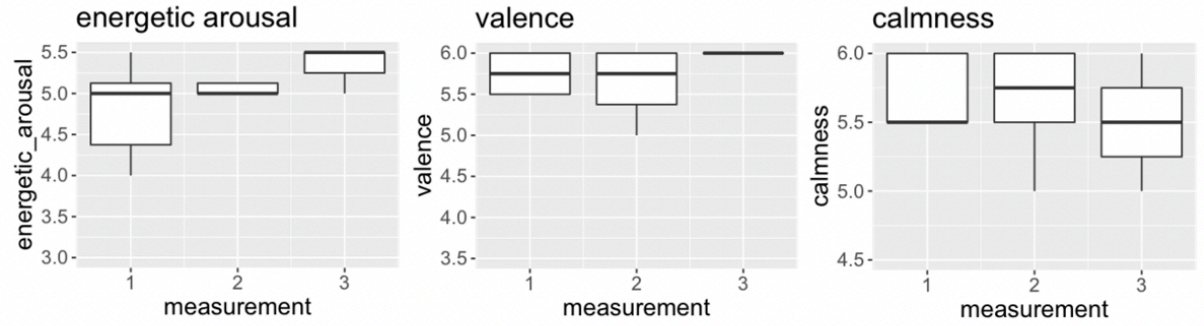

Figure 6. The indicated values (1-6) of the dimensions energetic arousal, valence and calmness for measurement timepoint 1 (PRE), measurement timepoint 2 (POST) and measurement timepoint 3 (FoUp1h) for patient 10. The boxplots display the median and the 2nd and 3rd quartile.

3.2.5 Discussion

In our study, we evaluated the feasibility of an intensive longitudinal case study design in forensic psychiatry to determine whether forensic patients are content to complete several data assessments per day over the course of several weeks, with feasibility operationalized by the compliance rate. Herein, single case studies were performed to examine the effects of ST on momentary affective states (energetic arousal, valence, calmness); the completion of these assessments reflect one aspect of feasibility. The findings reveal effects of ST in forensic psychiatric patients with different conditions.

On the one hand, our results provide insight into the feasibility of an intensive longitudinal design with respect to the compliance rate. Intensive longitudinal case studies, however, also bring new challenges, such as a high effort for the patients and thus a declining compliance rate. The compliance rate of >63% was only based on three patients. Concerning the challenge due to the compliance rate, our findings showed that out of ten participants, three subjects dropped out before the end of the study. Four additional participants did not provide sufficient data for analysis. Ultimately, three patients provided data that were suitable for analysis. Thus, the compliance rate was ≤37% in seven out of ten patients. Our data show that single case studies are able to express heterogeneity more precisely. Regarding the low compliance rate in our study or other studies with special populations such as forensic psychiatric subjects (Wynaden et al., 2012), the very different daily routines of the participants made it difficult to determine the appropriate measurement timepoints at which all participants could be reached for the FoUp1h measurement timepoint. Of the three intervention measurement timepoints, the FoUp1h was extremely difficult to implement (see Table 1) since the patients had to be actively sought. Reaching the participants for this intervention measurement timepoint was extremely difficult, while reaching the subjects for the PRE and POST measurement timepoints was easier.

On the other hand, our single case analyses reveal that the results are heterogeneous. Except for energetic arousal, the effects are heterogeneous overall. The rate of missing data was high in our study. We did not have a sufficient amount of data per patient for a proper single-case analysis. Power analyses revealed that the study was underpowered in all three patients (patient 1: 0.39; patient 2: 0.36;

patient 10: 0.26). For a sufficiently powered study (0.80), at least 73 data per analysis would have been needed (Faul et al., 2007). The many missing data can be explained by the fact that a lack of motivation quickly spread. After two weeks of the study, the patients had to be extremely motivated to continue filling out the questionnaires. The fourth and last week of the study had the most missing data, which is why the study was terminated after four weeks. Ultimately, only the people who participated at enough measurement timepoints could be included. Additionally, the FoUp1h measurement timepoint was a huge barrier because there were only very few patients left at that time. Our low sample size of ten participants represents the normal sample size in forensic psychiatric ST. Concerning the effects of ST on affective states, none of the three affect dimensions changed significantly between the three measurement timepoints. There were low to medium differences between the three measurement timepoints on energetic arousal, although these differences were nonsignificant. It must be noted that two of the three patients started with high values, and thus, no large increases could be expected. Our findings are partly in line with previous results: An intervention study showed positive associations between a sport and exercise therapy program (three months with a 90-minute session twice a week) and affective states in a single case study with one person diagnosed with posttraumatic stress disorder (Ley et al., 2018). As the duration of the program increased, positive affective states were perceived more often (Ley et al., 2018). A meta-analysis examining within-person changes in affective responses to physical activity in people with depression shows that acute bouts of physical activity moderately improve affective states (Bourke et al., 2022). The discrepancy between these findings and the findings of our study is due to the fact that forensic psychiatric studies present challenges that differ from the challenges associated with studies among patients with mental illness without a forensic connection. Forensic psychiatry has stricter rules, and thus, there is less freedom in the design and implementation of studies in ST.

Further research in this area is needed. This intervention provides initial approaches with the special population of forensic psychiatric patients.

Limitations

It should be noted that repeated-measures ANOVA was conducted with normality and variance homogeneity partially being present since other statistical methods would not have produced more significant results either. Moreover, it was used for data that all came from the same individual. There is a possibility that this could have limited the variability between measurements and led to inaccurate results.

In addition, it must be noted that a sufficiently powered study (0.80) was not achievable due to the small amount of data.

The high baseline values on the affective dimensions for two patients might represent ceiling effects.

Forensic psychiatric patients are heterogeneous, and the individual effects of interventions on their affective states are also heterogeneous. Therefore, the results obtained herein can hardly be generalized. Even patients with the same diagnosis can present a different symptoms and medication regimes; therefore, it is extremely challenging to compare or equate one forensic patient to another.

3.2.6 Implication

This study suggests that an intensive longitudinal case study design in forensic psychiatry is feasible and that ST has small to medium short term effects on affective states in individual patients who show a compliance rate of >63%. Compared to a between-subject design, we only used data of patients with an appropriate compliance rate for the evaluation.

However, the study design needs intensive revision to increase the compliance rate for particular study samples such as forensic patients. For example, a longer study duration and a survey of PRE and POST measurement timepoints alone could ensure a better compliance rate. Future studies should consider that data collection timepoints must be firmly integrated into the patients' schedule (especially for the FoUp1h measurement). In collaboration with the facility, an individualized plan should be developed for each patient so that they are able to complete each questionnaire at every measurement timepoint.

Especially for longer-term data collection, participants of the study could be provided with a study smartphone (digital data collection). They could be reminded about the digital questionnaire via a signal tone, thereby enabling data collection even on days without ST to evaluate whether and to what extent patients feel better on days with ST.

Furthermore, participation in a study is only meaningful for patients who regularly participate in ST. In our study, it was shown that patients who regularly participated in ST also completed this study with a compliance rate of >63%. Patients who did not participate regularly in ST were more likely to drop out of the study or not to participate conscientiously. If only patients who regularly participate in ST are included in a study, less missing data can be expected. Data collection on at least 2 days of ST per week (à 3 measurement timepoints) over a period of at least 12 weeks is reasonable and realistic. Another option is to stagger the reward (a small reward after each week and a large reward at the end of the study).

Further studies, e.g., multicenter studies, need to find out how and to whom the results can be generalized (patients with same diagnosis, same sex, similar age, similar medication, etc.).

3.2.7 Conclusion

Due to the abovementioned challenges (heterogeneity, low sample size, low compliance rate) in conducting studies in ST in forensic psychiatry, intensive longitudinal case studies are a possible approach to address heterogeneity and the low sample size. To counteract the high effort of data delivery for the patients and the associated low compliance rate, a change of the study design (e.g., digital data collection) and a fixed establishment of the measurement timepoints in the patients' schedule could improve the power of intensive longitudinal case studies.

3.2.8 Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

3.2.9 Ethics Statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

3.2.10 Author Contribution

VR and MK contributed to the conception and design of the study and wrote sections of the manuscript. VR organized the database, performed the statistical analysis, and wrote the first draft of the manuscript. All authors contributed to the article and approved the submitted version.

3.2.11 Funding

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3.2.12 Acknowledgments

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3.2.13 Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

3.2.14 Publisher's Note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

3.2.15 Supplementary Material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1111602/full#supplementary-material

1. One-time initial questionnaire:

Im Allgemeinen fühle ich mich…	stimme ganz und gar nicht zu	stimme nicht zu	stimme eher nicht zu	stimme eher zu	stimme zu	stimme voll und ganz zu
…zufrieden.	☐	☐	☐	☐	☐	☐
…ausgeruht.	☐	☐	☐	☐	☐	☐
…ruhelos.	☐	☐	☐	☐	☐	☐
…schlecht.	☐	☐	☐	☐	☐	☐
…schlapp.	☐	☐	☐	☐	☐	☐
…gelassen.	☐	☐	☐	☐	☐	☐
…müde.	☐	☐	☐	☐	☐	☐
…gut.	☐	☐	☐	☐	☐	☐
…unruhig.	☐	☐	☐	☐	☐	☐
…munter.	☐	☐	☐	☐	☐	☐
…unwohl.	☐	☐	☐	☐	☐	☐
…entspannt.	☐	☐	☐	☐	☐	☐

	stimme ganz und gar nicht zu	stimme nicht zu	stimme eher nicht zu	stimme eher zu	stimme zu	stimme voll und ganz zu
Ich stehe häufig vor Unerledigtem und weiß nicht, was ich tun soll.						
Es fällt mir schwer, mich selbst zu unterhalten.						
Viele Dinge, die ich tun muss, wiederholen sich und sind monoton.						
Es braucht mehr Anregung, um mich in die Gänge zu bringen, als bei den meisten anderen Menschen.						
Die meisten Dinge, die ich mache, motivieren mich nicht.						
In den meisten Situationen fällt es mir schwer, etwas zu finden, was ich tun oder sehen kann, um mein Interesse aufrechtzuerhalten.						
Einen Großteil der Zeit sitze ich einfach rum und mache nichts.						
Ich fühle mich halb tot und stumpf, es sei denn, ich mache etwas Aufregendes oder sogar Gefährliches.						

2. Recurring questionnaire: Current state and boredom

In diesem Moment fühle ich mich…

sehr müde							sehr wach
sehr zufrieden							sehr unzufrieden
sehr unruhig							sehr ruhig
sehr energiegeladen							sehr energielos
sehr unwohl							sehr wohl
sehr entspannt							sehr angespannt

Im Moment bin ich…

sehr gelangweilt										überhaupt nicht gelangweilt

3.3 How far are N-of-1 Studies Suitable Evaluation Designs in Forensic Psychiatric Sports Therapy? A Methodological Discussion.

Published as:

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3.3.1 Abstract

Introduction: Some evidence showed positive effects of sports therapy in forensic settings. Most of these evaluation studies analyzed between-subject relations and used RCTs (randomized controlled trials) to investigate intervention effects. RCTs normally randomize participants to an intervention and a control group with the intention to compare averaged group-findings. However, such averaged results, which are based on group effects may not apply to every single forensic patient as they do not adequately address that these patients are unique due to their complex psychopathology. Thus, RCTs do not adequately address the following circumstances especially relevant in forensic settings: heterogeneity and low sample size of therapy groups and low compliance rate of forensic patients. To address these challenges, it could be worthwhile to focus on within-subject relations by using N-of-1 studies. *Methods:* This viewpoint summarizes the possibilities and limitations of N-of-1 study designs regarding the challenges heterogeneity, low sample size and a low compliance rate when evaluating forensic sports therapy. *Results:* N-of-1 studies offer a useful addition in the evaluation of sports therapy in forensic psychiatry. They are able to evaluate individual effects and they increase the power of the study by increasing the number of measurements. Nevertheless, they are associated with limitations, for example increased effort due to frequent measurements and long study duration or the difficulty to generalize the results. *Conclusion:* Future studies should implement N-of-1 study designs in forensic psychiatric sports therapy to gain evidence and should find solutions to deal with the limitations (e.g., digital technology).

Keywords: N-of-1 studies, within-subject design, sports therapy, evaluation.

To investigate health-enhancing effects of sports therapy in forensic psychiatry, evaluation studies normally use RCTs (randomized controlled trials) (Reimer et al., 2022a; Wynaden et al., 2012). However, such a design does not adequately address the challenges of patients with severe mental illnesses like forensic psychiatric patients (Ross et al., 2016): First, each patient's symptoms are highly individual with a different severity and complexity (Grubaugh et al., 2011). Thus, homogeneous patient groups are not possible due to the heterogeneous characteristics of forensic patients (Ross et al., 2016). In sports therapy, all patients are treated together in groups, since no subdivision is made into diagnoses or paragraphs or severity of the disease, resulting in very heterogeneous groups of sports therapy (Ross et al., 2016). Second, psychiatric facilities are characterized by a rather small patient group in sports therapy (Wynaden et al., 2012; Beebe et al., 2005) and lower fluctuations in the patient group, because forensic patients normally stay multiple months or years in stationary therapy facilities (Ross et al., 2013). Third, patients with serious mental illnesses often show low treatment compliance (Corrigan et al., 2014; Chakrabarti, 2014).

Previous evaluation studies are normally RCTs, which mainly investigated between-subject effects between patients of the intervention and control group and are suitable to investigate the average effect of an intervention for a certain group (Zwarenstein et al., 2021). Such RCTs are suitable for single, well-defined disorders or diagnoses (Fielenbach et al., 2017) but challenging when investigating patients with severe mental diseases (Bradbury et al., 2020). One advantage of RCTs with sufficient power is to average effects of specific interventions in forensic sports therapy (Zwarenstein et al., 2021). However, due to high heterogeneity within forensic patients, such averaged results may not apply to every single patient (Zuidersma et al., 2020; Epstein & Dallery, 2022) as they do not adequately address that forensic patients are unique due to their complex psychopathology (Ross et al., 2016). Patients in forensic psychiatry vary strongly regarding their diagnosis and risk factors (van der Veeken et al., 2017) as there are multiple factors that contribute to the development of mental illness and delinquent behavior in forensic psychiatric patients (Dean, 2015). Therefore, the results of RCTs in forensic psychiatry cannot be transferred to each forensic patient (Fielenbach et al., 2017) and indicate that this classic intervention design might not be appropriate for forensic psychiatry.

To conduct adequate evaluation studies in forensic sports therapy the specific circumstances of forensic settings (heterogeneity, low sample size, and low compliance rate) should be addressed. N-of-1 studies are able to face these challenges (Zuidersma et al., 2020; Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022) and are of particular interest in the healthcare sector (McDonald & Nikles, 2021). They provide more detailed information about the individual effects in health and well-being outcomes than RCTs (Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022), cohort studies or case-control studies (Zuidersma et al., 2020). This brief report addresses the specific circumstances of forensic settings and presents possibilities and limitations of N-of-1 studies to evaluate effects of forensic sports therapy.

3.3.2 Definition of N-of-1 studies

N-of-1 studies (observational or experimental (Zuidersma et al., 2020)) are flexible (Epstein & Dallery, 2022) and focus on a single patient (Marwick et al., 2018). Instead of the term N-of-1 study, the following terms case study (Kwasnicka et al., 2019; McDonald & Nikles, 2021; Lillie et al., 2011), single-subject study (Zuidersma et al., 2020), or single-patient study (Vieira et al., 2017) are also used in the literature. In contrast, a case report presents a descriptive observation of a patient (Vieira et al., 2017). Compared to N-of-1 studies, case reports are often used in forensic psychiatry (Hanson et al., 2014).

3.3.3 Possibilities and Limitations of N-of-1 Studies

Heterogeneity

Heterogeneity in forensic psychiatry means that each patient shows a different expression of complex symptoms (Grubaugh et al., 2011) and thus no homogeneous picture of forensic patients can be depicted (Ross et al., 2016). That argues for evaluating patients in N-of-1 studies to gain more details about the individual changes (Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022).

For example, a volleyball intervention with forensic psychiatric patients (N=19) improved social competent behavior (Reimer et al., 2022a). A further evaluation would be valuable about the extent to which the different dimensions of social competence (communication skills, social responsibility, perspective taking) changed for whom of the forensic patients. Similar applies to another study (Wynaden et al., 2012), where forensic patients have been evaluated in an exercise program and reported positive effects on psychiatric symptoms (e.g. improving mood, coping with stress), level of fitness, confidence, and self-esteem for the intervention group. To address heterogeneity in forensic patients, literature shows evidence by combining an RCT (n=50) and an N-of-1 study (n=4) to investigate a neurofeedback protocol (Fielenbach et al., 2017). Besides the RCT design, four patients were additionally examined in an N-of-1 study design (Fielenbach et al., 2017). Results of the N-of-1 study showed that three patients completed all study phases, none of the patients followed the training like planned and the behavioral measures varied between the patients (Fielenbach et al., 2019).

Nevertheless, averaged conclusions about the population based on N-of-1 studies are difficult (Zuidersma et al., 2020). A possible solution could be to conduct replications of various N-of-1 studies with the same research topic (Zuidersma et al., 2020; McDonald & Nikles, 2021). Due to economic reasons and to get statements for more than one patient, aggregated or cumulative N-of-1 studies might be able to infer individual effects on specific patient groups or patient characteristics if the N-of-1 studies show similar effects with regard to sports therapy (Kwasnicka et al., 2019; McDonald & Nikles, 2021). Moreover, it could indicate the possibility to generalize the effects to other forensic patients (Zuidersma et al., 2020).

Low sample size

A low sample size in psychiatric sports therapy groups (Ross et al., 2013) leads to low statistical power in evaluation studies (Button et al., 2013). To increase the power of a study (Bradbury et al., 2020; Zuidersma et al., 2020; Kwasnicka et al., 2019), N-of-1 studies use data assessments over a long time (time-series data) (Zuidersma et al., 2020; Vieira et al., 2017), because in N-of-1 studies the patient is in both, an intervention situation and a control situation (Zuidersma et al., 2020). However,

assessing data over a long period puts high requirements (Zuidersma et al., 2020) on forensic patients due to their low capacity of motivation (Ross et al., 2016).

Low compliance rate

Personalized feedback motivates people to increase their level of physical activity (Ghanvatkar et al., 2019). N-of-1 studies might face the challenge of low compliance rate due to personalized feedback that motivates the patient to endure until the end of the study or due to ABA-designs or observational study designs (Zuidersma et al., 2020). The long accommodation period of forensic patients offers the opportunity to conduct intensive longitudinal studies and to assess patients over a long period of time (Ross et al., 2013).

3.3.4 Conclusion

This brief report discusses the possibilities and limitations of N-of-1 studies to evaluate sports therapy in forensic settings. In health psychology and behavioral medicine, N-of-1 studies have still received too little recognition and application [26] and are rarely used in psychiatry due to the effort for the patients (Zuidersma et al., 2020).

To evaluate sports therapy in forensic psychiatry settings, N-of-1 studies might be worthwhile to supplement existing evaluation designs, because they address the challenges of evaluation studies in forensic sports therapy more adequately, for example in the evaluation of individual effects or the increase of the power of the study by increasing the number of measurements (sample size). Nevertheless, they are associated with limitations, for example the high requirements due to the frequent measurements and the long study duration or the poor generalization of the results.

Future studies should implement N-of-1 study designs in forensic psychiatric sports therapy to gain evidences. If this type of study design contributes to more detailed knowledge, then solutions to deal with the limitations (e.g., digital technology) need to be considered (McDonald & Nikles, 2021; Lillie et al., 2011). It is possible that for

patients with the same diagnoses, the evidence of N-of-1 studies result in a recommended treatment.

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Conflict of interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria, educational grants, participation in speaker's bureaus, membership, employment, consultancies, stock ownership, or other equity interest, and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

4 General Discussion

4.1 Lack of Research in Forensic Psychiatric Sports Therapy

The aim of this cumulative dissertation was to evaluate sports therapy in forensic psychiatry to offer a first effect analysis and to make recommendations for future research in forensic psychiatric sports therapy concerning appropriate study designs.

The initial chapters (Chapter 1.1 and Chapter 1.2) highlight a very significant need for research in the field of forensic psychiatric sports therapy. The published review (Reimer et al., 2022b) illustrates the substantial underrepresentation of this research area. Based on the published paper, only one study from Australia (Wynaden et al., 2012) has dealt with the marginalized group of forensic patients and investigated the effect of physical training. This shows enormous potential for research in forensic psychiatric sports therapy as the results of our published review reveal hopeful effects of physical activity on the six sports therapeutic objectives mentioned by Ross et al. (2016): *social skills*, *physical and psychological activation*, *body experience*, *self-image*, *stabilization of personality*, with most of the evidence relating to the first two objectives mentioned here (Reimer et al., 2022b). In contrast, there is no evidence on the objective *coping with conflict and frustration*, which is particularly unfortunate since this skill is omnipresent in the daily (forensic) psychiatric setting (Reimer et al., 2022b). These objectives provide an extremely important foundation and directional guidance, as they were stated directly by experts in the field of sports practice (Reimer et al., 2022b). This considerable need for research therefore shows that it is now time to take action and that the intensively researched and compiled theoretical knowledge must be implemented in practical sports therapy. There is an urgent need to find out what interventions have what effects and how interventions in forensic psychiatric sports therapy must be designed in order to do justice to each individual patient. The published review (Reimer et al., 2022b) also highlights the possibility to plan RCT-studies on that basis, which was put into practice in the GDivP study (Chapter 2.2), in which *social competence* was the main subject of investigation.

4.2 Effects of Sports Therapy on Social Competence

The results of the published GDivP study (Reimer et al., 2022a) reveal first promising findings on the effects of a specific sports intervention on dimensions of *social competence* in forensic psychiatric patients. *Communication skills* and *social responsibility* were significantly improved in the intervention group as a result of their participation in the volleyball workshop (Reimer et al., 2022a). It is important to note that in the comparison of the intervention group with the control group at measurement timepoint 2, the intervention group had higher mean values for *social responsibility* - but only in individual tests - and not true for a general statement (Reimer et al., 2022a). As outlined in chapter 2.3, the between group comparison does not provide a clear indication of the individual extent to which each patient benefited from the volleyball workshop. A precise description of the results of individual effects of sports therapy in forensic psychiatric patients can therefore not be made showing that traditional study designs fail to take into account the patient *heterogeneity* which is characteristic for forensic patients.

In our feasibility study (Reimer & Kanning, 2023a) we outlined that *heterogeneity* and *low sample size* are the two main challenges for sports therapy research in forensic psychiatry. Although the GDivP study (Reimer et al., 2022a) acknowledges the need for larger sample sizes to support findings in traditional RCT designs, it is evident that *low sample sizes* will remain a challenge in future studies, given the reality of forensic psychiatric sports therapy. Our GDivP study (Reimer et al., 2022a) and our feasibility study (Reimer & Kanning, 2023a) clearly showed that the research in this dissertation must go in a different direction than the originally planned evaluation of the sports therapy objectives according to Ross et al. (2016). The urgent need for a suitable study design that addresses the individual patient is inevitable and must be tested in a practical implementation (Reimer & Kanning, 2023a).

4.3 Methodological Issues

From the described circumstances (Chapter 4.2), it can be concluded that first, forensic psychiatric patients must be considered individually and second, the *sample size* must be increased. The feasibility study (Reimer & Kanning, 2023a) offers the possibility to integrate both of those requirements. Case studies offer a favorable opportunity to deal with patients individually (Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022) and thus to account for *heterogeneity* (Zuidersma et al., 2020; Kwasnicka et al., 2019; McDonald & Nikles, 2021; Goyal et al., 2022) which plays a central role in forensic psychiatry (Ross et al., 2016): Thus, it seems that it can be assumed that in the context of evaluation studies, the challenge *heterogeneity* can be addressed adequately with a case study / N-of-1 study design. An intensive longitudinal design offers the opportunity to conduct measurements over a long period of time and increase the *sample size* (Bradbury et al., 2020; Zuidersma et al., 2020; Kwasnicka et al., 2019). The intensive longitudinal approach of our feasibility study (Reimer & Kanning, 2023a) is a logical consideration, but with our chosen study design the *low sample size* could not be addressed, on the contrary: the study had to be terminated after four weeks due to the decreasing motivation as described in the publication. In addition to the identified challenges of *heterogeneity* (Reimer et al., 2022b; Reimer et al., 2022a) and the *low sample size* (Reimer et al., 2022a; Reimer & Kanning, 2023a), the feasibility study (Reimer & Kanning, 2023a) also reveals a third challenge, namely the *low compliance rate*. Drawing from the findings of the published paper (Reimer & Kanning, 2023a), *low compliance rates* lead to underpowered studies, emphasizing the need for urgent and comprehensive optimizations of the case study design. Using digital technologies, could help to improve *compliance*, by reducing participant burden (Reimer & Kanning, 2023a; Reimer & Kanning, 2023b).

The implementation of appropriate study design improvements has the potential to enhance the robustness of the evidence base. Moreover, by cumulating or aggregating the results of multiple case studies / N-of-1 studies, systematic reviews could be conducted to evaluate the effects of sports therapy in forensic psychiatric patients, as described in Reimer & Kanning (2023b). For this, however, the power of the studies must be increased by raising the number of measurement timepoints and at the same time counteracting the higher participant burden (Reimer & Kanning,

2023a; Reimer & Kanning, 2023b). Here again, the implications in Reimer & Kanning (2023a) must be referred to, for instance, only PRE and POST measurements, integration of measurement timepoints in patients' schedule, study smartphones, participants in the study should be patients that regularly participate in sports therapy or a staggered reward.

5 Conclusion and Future Directions

The research presented in this dissertation is also associated with a number of limitations. It must be noted that the results of the GDivP study (Reimer et al., 2022a) as well as the feasibility study (Reimer & Kanning, 2023a) are only based on patients of the ZfP Reichenau. As a result, caution should be exercised when generalizing our findings to other forensic patients.

In summary, it can be said that when conducting sports therapeutic research with forensic psychiatric patients, one should consider taking advantage of the many benefits of case studies / N-of-1 studies, especially in regard to the *heterogeneity*, which was shown in our feasibility study (Reimer & Kanning, 2023a). However, the substantial amount of missing data in this study highlights the necessity of comprehensive revisions (Reimer & Kanning, 2023a). The GDivP study (Reimer et al., 2022a) used a traditional RCT design, but would certainly have been suitable for a case study design. After all, data from 15 patients could be used in this study. If instead of or in addition to the within-group changes (H1a, H1b, H1c) in the intervention group, within-subject changes had been assessed, precise statements about the individual changes in the dimensions *perspective taking*, *social responsibility* and *communication skills* would have been possible. Intensive longitudinal data during that time period could have helped to identify potential trends across one or more of the dimensions. These are, of course, assumptions rather than evidence-based statements. And one should note that in the GDivP study (Reimer et al., 2022a), four patients terminated the study prematurely, but each of the 15 patients that completed the study could be included in the analysis. In comparison, the feasibility study (Reimer & Kanning, 2023a) however resulted in drastically different *compliance rates*: Of a total of 10 study participants, one patient did not participate at all, two patients dropped out prematurely, and of the remaining seven patients who completed the study, another four patients had to be excluded because they provided not enough data, which ultimately led to the evaluation of data from only three patients. Certainly, the longer study duration is likely one contribution factor to this outcome: three days in the GDivP study (Reimer et al., 2022a) compared to four weeks in the feasibility study (Reimer & Kanning, 2023a), in which consequently, the patients' motivation declined progressively throughout the feasibility study. In addition, patients were not asked to complete questionnaires in

the GDivP study (Reimer et al., 2022a), an aspect patients found increasingly burdensome during the feasibility study (Reimer & Kanning, 2023a). Nevertheless, it is clear from our feasibility study (Reimer & Kanning, 2023a) that a traditional RCT design would not have been possible, partly because of the large amount of missing data and partly because of the patient *heterogeneity*. Furthermore, it should be emphasized that an investigation over a longer period of time is explicitly desired in patients of forensic psychiatry, since the patients are accommodated there over a long period of time, two years to several years (Schmid et al., 2016), and (should) also participate in sports therapy during this entire period. Therefore, the intensive longitudinal case study design of our feasibility study offers a good first approach, but also shows that the study design needs to be revised in order to increase the *compliance rate* and thus possibly collect data over several weeks and months (Reimer & Kanning, 2023a; Reimer & Kanning, 2023b).

At present, it cannot be determined to what extent a revision of the intensive longitudinal case study design can increase the *sample size* and improve *compliance*. This needs to be investigated in future studies. Regarding potential study objectives, the sports therapeutic objectives according to Ross et al. (2016) serve as valuable guidance. Effects of sports therapy on *social competence* could be investigated for the first time by the GDivP study (Reimer et al., 2022a). Here, it is certainly interesting to explore whether short-term improvements in *social competence* achieved through sports therapeutic interventions can be maintained in the long term. The remaining sports therapeutic objectives also urgently need to be investigated within the framework of intervention studies. The sports therapeutic objective *physical and psychological activation* (Ross et al., 2016) would be particularly well-suited for case studies, as our review (Reimer, Ross, & Kanning, 2022) revealed promising effects of engaging in physical activity among patients with mental illness. In cooperation with Professor Dr. Thomas Ross and Professor Dr. Martina Kanning, the following considerations have already been compiled: When investigating the effects of sports and exercise therapy in forensic psychiatric patients, it is interesting to know to what extent *physical and psychological activation*, e.g., through fitness endurance training using ergometers, moderates the various outcomes and adherence of forensic psychiatric patients. Evidence demonstrates that in patients with severe mental illness, physical activity and fitness are associated with several health-related outcomes, in the form of improvements in symptoms,

cardiovascular outcomes, social functioning, and quality of life (Vancampfort et al., 2017; Firth et al., 2015; Rosenbaum et al., 2014) and improved cognitive functioning (Erickson et at., 2019; Firth et al., 2017). This leads to the recommendation that physical activity aimed at improving fitness should be used as an adjunctive therapy as evidence from a meta-analysis for depression and evidence from systematic reviews and RCTs for schizophrenia shows (Stubbs et al., 2018). For other severe mental illness, physical activity may be a useful addition to therapy (intervention studies or observational studies) (Stubbs et al., 2018). It is discussed that fitness moderates the effects, with mediators at different levels (cellular and molecular changes, structural and functional changes in the brain, behavioral and socio-emotional changes) being suspected (Stillman et al., 2016). To date, there is no evidence regarding the moderating effect of fitness and how it relates to *physical and psychological activation* in forensic patients. Similarly, there is currently a lack of evidence regarding the extent to which the sports therapeutic objectives *correction of self-image*, *changes in body experience* or *stabilization of personality* can be improved in forensic psychiatric patients with the help of a fitness endurance training. There is a need for future studies to evaluate the long-term effects of physical activity and fitness or the moderating effect of fitness in forensic psychiatric patients.

The primary and secondary outcomes of interest for such a controlled longitudinal case study could be:

- Psychopathological effects (e.g., well-being)

- Executive (cognitive) functions

- General forensic outcomes (see forensic sports therapeutic objectives)

- Cardiovascular changes

A study duration of at least 12 weeks is advisable (Reimer & Kanning, 2023a). Nevertheless, a longer study duration (ranging from one to two years), with follow-up measurements conducted every three to six months, is desirable. Due to the described issues of motivation (Stellmacher & Häbler, 2016) and impulsivity (Stellmacher & Häbler, 2016; Billen et al., 2019), irregular participation could occur as in our feasibility study (Reimer & Kanning, 2023a). The implications mentioned in Reimer et al. (2023a) could be possible approaches therefore. Other factors that

need to be considered are the influence of (changing) medication, depressive episodes, relapses, transfer of a patient to another ward, etc. When fitness endurance training is performed with ergometers, the risk of injury is expected to be very low and thus no dropout due to injury is expected, which was a problem in our GDivP study (Reimer et al., 2022a). Consideration should be given to aggregate or cumulate the results of these single case studies (Reimer & Kanning, 2023b).

In conclusion, the ideas described above could serve as valuable orientation for conducting future research. With our two intervention studies (Reimer et al., 2022a; Reimer & Kanning, 2023a), this dissertation plays a crucial role in contributing to the overall evaluation of sports therapy in forensic psychiatry, as outlined at the beginning (Chapter 1.1 and Chapter 1.2) and provides clear guidance for future research with the inclusion of the feasibility study (Reimer & Kanning, 2023a) and our methodological discussion (Reimer & Kanning, 2023b). Further evaluation is still urgently needed in this research area to better enhance the visibility and importance of sports therapy in forensic psychiatry.

6 Author Contributions

Review

Reimer, V., Ross T., & Kanning, M. (2022). Effects of sport therapy on psychosocial outcomes for forensic patients: A systematic literature review of evidence in mentally ill patients. *Sports Psychiatry, 1*, 107-15. https://doi.org/10.1024/2674-0052/a000007

Table 6. Author Contribution 1.

	Vanessa Reimer *Lead authorship*	Thomas Ross *Co-authorship*	Martina Kanning *Co-authorship*
Conceptualization	✓		✓
Methodology	✓		✓
Supervision			✓
Literature Research	✓		
Visualization	✓		
Writing – Original Draft	✓	✓	
Writing – Editing	✓	✓	✓

Study 1

Reimer, V., Arway, F., Bulla, J., & Kanning, M. (2022). Promotion of Social Competence with the Sports-Therapeutic Volleyball Program GDivP in Forensic Psychiatry: a Pilot Study. *Deutsche Zeitschrift für Sportmedizin, 73*, 70-76. https://doi.org/10.5960/dzsm.2021.518

Table 7. Author Contribution 2.

	Vanessa Reimer *Lead authorship*	Felix Arway *Co-authorship*	Jan Bulla *Co-authorship*	Martina Kanning *Co-authorship*
Conceptualization	✓			✓
Methodology	✓			✓
Supervision				✓
Data Collection	✓			
Data Analysis		✓		
Visualization	✓	✓		
Writing – Original Draft	✓	✓	✓	
Writing – Editing	✓	✓		✓

Study 2

Reimer, V., & Kanning, M. (2023). Does Sports Therapy affect Momentary Affective States? Feasibility of Intensive Longitudinal Case Studies in Forensic Psychiatry. *Frontiers in Psychiatry, 14*, 1111602. https://doi.org/10.3389/fpsyt.2023.1111602

Table 8. Author Contribution 3.

	Vanessa Reimer *Lead authorship*	Martina Kanning *Co-authorship*
Conceptualization	✓	✓
Methodology	✓	✓
Supervision		✓
Data Collection	✓	
Data Analysis	✓	
Visualization	✓	
Writing – Original Draft	✓	
Writing – Editing	✓	✓

Methodological discussion

Reimer, V., & Kanning, M. (2023). How far are N-of-1 studies suitable evaluation designs in forensic psychiatric sports therapy? A methodological discussion. *Sports Psychiatry,* 1-4.
https://doi.org/10.1024/2674-0052/a000049

Table 9. Author Contribution 4.

	Vanessa Reimer *Lead authorship*	Martina Kanning *Co-authorship*
Conceptualization	✓	✓
Methodology	✓	✓
Supervision		✓
Literature research	✓	
Writing – original draft	✓	
Writing – review & editing	✓	✓

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