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# Interventions with dance, yoga, and mindfulness to improve mental health among children and adolescents

ELIN ARESKOUG SANDBERG

CLINICAL SCIENCES, MALMÖ | FACULTY OF MEDICINE | LUND UNIVERSITY

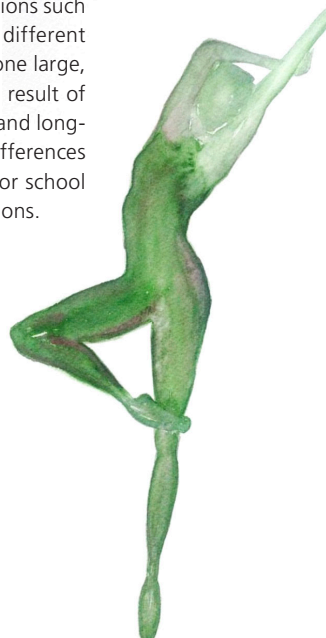
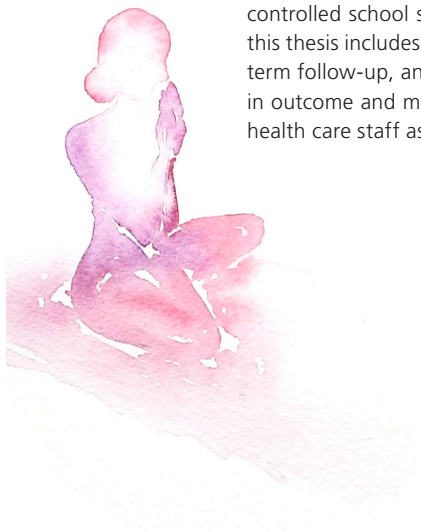


**ELIN ARESKOUG SANDBERG** completed medical school in 2017 and became a registered doctoral student at the School of Health and Medical Sciences at Örebro University the same year. After working with the Dance project and the



Just In Time Project for a couple of years, she moved and continued her doctoral studies, working with the Mindfulness project at the Center for Primary Health Care Research at Lund University. She is currently doing her residency at a primary health care center in Malmö in Skåne, Sweden. Since adolescence, yoga has been one of her main interests, and alongside medical studies she is a licensed yoga instructor and has been teaching and educating in yoga for adolescents and adults as well as health care staff.

Mental health problems are increasing globally in all ages and are currently among one of the most serious public health challenges. Finding easily applicable methods for promoting mental health as well as preventing and treating mental health symptoms, as a complement to the regular healthcare at early ages is needed. The interest in using alternative, body-mind interventions such as dance, yoga and mindfulness is increasing. In this thesis, two different randomized controlled studies including dance and yoga as well as one large, controlled school study including mindfulness are investigated. The result of this thesis includes objective as well as subjective measures in short and long-term follow-up, and highlights some important factors related to differences in outcome and may provide inspiration and practical information for school health care staff as well as researchers in designing future interventions.



Interventions with dance, yoga, and mindfulness to  
improve mental health in children and adolescents



# Interventions with dance, yoga, and mindfulness to improve mental health among children and adolescents

Elin Areskoug Sandberg



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DOCTORAL DISSERTATION

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<b>Abstract</b> <p><b>Introduction:</b> The increasing mental health problems among young people are currently among the most serious health challenges globally. Finding early interventions to break this trend is needed.</p> <p><b>Aim:</b> To investigate the effect of three different non-pharmacological interventions on mental health symptoms in children and adolescents.</p> <p><b>Material and methods:</b> "The Dance Project" was a randomized controlled study to investigate the effect of an 8-month dance intervention on daytime tiredness and alertness among adolescent girls with internalizing problems. The "Just In TIME project" was a randomized controlled study to investigate the effects of an 8-month-long dance and yoga intervention on saliva cortisol and self-reported stress levels among girls with functional abdominal pain disorders. "The mindfulness project" was a controlled school study, where mindfulness was provided daily for 10 weeks to estimate the effect on depression and anxiety symptoms immediately after intervention and at one-year follow-up in children and adolescents aged 6-16 years.</p> <p><b>Results:</b> The dance project resulted in decreased daytime tiredness in the intervention group compared to the control group. The "Just in TIME" intervention resulted in improved cortisol levels during the intervention, compared to controls, but no effects were seen at the end of the study. No overall mindfulness-induced differences in depression and anxiety symptoms in school children, after the intervention or after one year were detected. However, symptom-improvement was observed in the subgroup that received teacher-led mindfulness compared to audio file led after the intervention. This effect did not remain after one year.</p> <p><b>Conclusion:</b> Positive outcomes were mainly observed in dance and yoga interventions. Some effects were seen immediately after the mindfulness intervention, but they did not remain after one year. The thesis emphasizes the importance of evaluating early interventions for young people, to prevent or reduce mental health problems. More research is needed to find evidence-based methods that hold the potential to reach a large number of individuals at a low cost to promote mental health.</p>		
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Elin Areskoug Sandberg



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**MADE IN SWEDEN** 

*To everyone trying to be human*

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*I will never forget the smile on her face. She is giggling and bubbling as she enters the dance room. Putting her backpack to the side and taking her shoes off. She is eager to tell me about her day in school and how she has been looking forward to the dance class. Then comes the second girl. She is quieter, with a shy look on her face, she is looking at the floor, her hair hangs loose, almost covering her face, as if she was invisible. She quietly enters the room. The third girl appears, she is there with her mother, and does not want to let go of her hand. And then the fourth one. She enters smoothly and quietly; there is a calmness on her face, but it's almost impossible to feel what she is feeling, as she has been shutting it down towards herself and the rest of the world for a long time. Then comes the rest, one by one, all having their own stories and different reasons for being here.*

*I can recognize myself in each and every one of them. The giggling one, the quiet one, the shy one, the sad one, the cool and the tough one. For a moment, I contemplate about us all being here together. As I put on the warm-up song, and we, together, move around in the room, there is a light that shines through. All these stories go away as we dance together, slowly, landing here in the here and now. A rough day slowly fades away and is replaced by laughter, easy laughter, and lightness. The November darkness rests outside the windows, but in the here and now is another brightness. As if the darkness can't enter the room. Not even when I shut down the lights for the final relaxation in Savasana on the floor. All of us, resting inside our own bodies, next to each other. We are at home.*

*This is another type of medicine than the one I practice at my daily work at the emergency care or the primary care center. We don't talk about the symptoms here. We don't talk about the pain or the suffering and all of that life matters outside this room.*

*We rest.*

*And I can feel the medicine working in their bodies as well as in my own. It is a nurturing hour for all of us. A soft reminder, that life has to offer more than that normal every-day-life-matter. At the end of the class - when they have all left the room - I sit for a while in the stillness.*

*Feeling the impact.*

*I know some kind of healing just happened*

*If not in the girls*

*Absolutely and at least*

*In me*

*This is my thesis work, describing mind-body methods for improving mental health and wellbeing for children and adolescents. In complement to all statistical calculations, inclusion criteria, ethical considerations, methodological discussions, and risk of biases. Also, not forgetting the gaze in her eyes. The giggling, and the sight of them all moving together to the sound of the music. Rhythmic release of emotions and laughter. No statistical counting or power analyzes can ever replace what she told me later in the qualitative interview at the end of the intervention,*

*It feels so much better now...as if I can enjoy being myself, I feel Swag!*

*How does it feel to have Swag? I ask*

*Like I radiate something!*

*Did you never feel like that before?*

*Yes, sometimes maybe but not so often*

*How often do you feel Swag now?*

*Like every day. And if I don't feel it, I just put on one of the songs and dance, and then I feel it immediately!*

*This is for her, and for me. And for all and everyone who has ever felt low or sad or lonely. For everyone that knows that we need more than pills and prescriptions to feel whole and safe and secure. To everyone that knows that life matters. For everyone that believes that healing is possible at a deeper level. Everyone that believes in belonging. This is for every single one who has taken part in this work, contributing with their presence in the interventions or as control persons. To all the parents supporting us and their children. To all school teachers, principals and school nurses. To all educators and instructors. To all Swaggers. To all my fellow colleagues, supervisors, and members of the research team. And of course, to my family and friends supporting me through this process that has indeed, reflected life in many different ways and forms,*

*This is to all of you,*

*The greatest thank you I could possibly imagine,*

*To all my friends and to my family,*

*And not least, to all children and adolescents,*

*Follow the spark and the curiosity,*

*Life matters*

*Bring in the light and be the change*

# Definitions and abbreviations

BAI	Beck Anxiety Inventory
BDI	Beck Depression Inventory
BYI	Beck Youth Inventory
CBT	Cognitive behavioral therapy
Child-S	Children's Depression Screener
DMT	Dance movement therapy
DSM	Diagnostic and Statistical Manual of Mental Disorders
EEG	Electroencephalogram
FAPDs	Functional abdominal pain disorders
fMRI	Functional magnetic resonance imaging
GBD	Global burden of disease
GI tract	Gastro intestinal tract
HRV	Heart rate variability
HPA-axis	Hypothalamic pituitary adrenal axis
IBS	Irritable bowel disease
ICD	International Classification of Disease
MBCT	Mindfulness-based cognitive therapy
MBI	Mindfulness-based intervention
SDT	Self-determination theory
YBP	Yoga based practices



# Abstract

**Introduction:** The increasing mental health problems among young people are currently among the most serious health challenges globally. Finding early interventions to break this trend is needed.

**Aim:** To investigate the effect of three different non-pharmacological interventions on mental health symptoms in children and adolescents.

**Material and methods:** “The Dance Project” was a randomized controlled study to investigate the effect of an 8-month dance intervention on daytime tiredness and alertness among adolescent girls with internalizing problems. The “Just In TIME project” was a randomized controlled study to investigate the effects of an 8-month-long dance and yoga intervention on saliva cortisol and self-reported stress levels among girls with functional abdominal pain disorders. “The mindfulness project” was a controlled school study, where mindfulness was provided daily for 10 weeks to estimate the effect on depression and anxiety symptoms immediately after intervention and at one-year follow-up in children and adolescents aged 6-16 years.

**Results:** The dance project resulted in decreased daytime tiredness in the intervention group compared to the control group. The “Just in TIME” intervention resulted in improved cortisol levels during the intervention, compared to controls, but no effects were seen at the end of the study. No overall mindfulness-induced differences in depression and anxiety symptoms in school children, after the intervention or after one year were detected. However, symptom-improvement was observed in the subgroup that received teacher-led mindfulness compared to audio file led after the intervention. This effect did not remain after one year.

**Conclusion:** Positive outcomes were mainly observed in dance and yoga interventions. Some effects were seen immediately after the mindfulness intervention, but they did not remain after one year. The thesis emphasizes the importance of evaluating early interventions for young people, to prevent or reduce mental health problems. More research is needed to find evidence-based methods that hold the potential to reach a large number of individuals at a low cost to promote mental health.

# Original papers

This thesis is based on the following papers, referred to in the text by their Roman numerals.

- I. **Sandberg E**, Möller M, Särnblad S, Appelros P, Duberg A. “Dance intervention for adolescent girls: Effects on daytime tiredness, alertness and school satisfaction. A randomized controlled trial.” *Journal of Bodywork and Movement Therapies* 2020, Vol 26, 505-514.\*
- II. **Areskoug Sandberg E**, Duberg A, Lorenzon Fagerberg U, Mörelius E, Särnblad S. “Saliva Cortisol in Girls With Functional Abdominal Pain Disorders: A Randomized Controlled Dance and Yoga Intervention” *Frontiers in Pediatrics*. Vol 10, 765, 2022.\*
- III. **Areskoug Sandberg E**, Stenman E, Palmer K, Duberg A, Sundquist J, Sundquist K. “A 10-week school-based mindfulness intervention and symptoms of depression and anxiety among school children and adolescents: A controlled study”  
*Submitted*
- IV. **Areskoug Sandberg E**, Stenman E, Palmer K, Duberg A, Sundquist J, Sundquist K. “A school-based mindfulness intervention and symptoms of depression and anxiety among school children and adolescents, a one year follow up”  
*Manuscript*

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# Introduction

## Preamble

Growing up is a stressful time in life. Transitioning from being a child to becoming an adolescent and later an adult constitutes many challenges along the way. The metaphor “Storm and Stress” was already described in 1904 referring to adolescence (Hall, 1905) and is probably as relevant now as then, and today, also faced with challenges such as social media, a global pandemic, alarming climate changes, and an overall fast-moving and highly developing and changing society.

In addition to the individual development of finding one’s identity, forming intra- and interpersonal relationships, performing in school and in leisure time, undergoing puberty involves a lot of stress during a vulnerable time in life. Frequent reports describe an increase in mental health problems among young people all over the globe. Stress-related and mental health problems can present in many ways, from the experience of tension and worry to feeling sad, low, or anxious, having sleeping problems or somatic complaints such as headache, stomach ache or tiredness to manifested mental health problems such as depression or anxiety disorders. This growing trend calls for action. Epidemiologic studies and reports are many, however, intervention studies of evidence-based methods for dealing with these problems at an early age are still scarce. Thus, preventive methods at an early age can have an important impact across a long life span and helps to develop sustainable and resilient young adults. Questions such as how to find risk individuals at an early stage, how to prevent and treat them, and how to work preventively and build resilience need to be answered.

In this thesis, we look at mental health problems, how to deal with them and how to prevent them, from a variety of angles. The introduction chapter includes an epidemiologic overview and description of mental health problems and how it manifests in girls and boys. It also includes a theoretic framework of how to potentially work curatively and preventively with these conditions by improving self-regulation, coping strategies, and emotional awareness using non-pharmacological mind-body interventions. Further on in this thesis, three different studies based on the theoretic framework previously described are presented: “The dance project” and its effects on

tiredness among adolescent girls with internalizing problems, The “Just In TIME project” and its influence on stress among young girls with functional abdominal pain, and lastly, the “Mindfulness project” and its impact on symptoms of anxiety and depression among students in schools.

*Because, you know, everywhere in our society it's all about grades or credits and stuff, and it's so nice to go to the dance class. Because there you can let go of everything else and, like, just be. Without always trying to achieve something. That's amazing.*

—S

*Quote from one of the participants in the Dance project (Duberg et al., 2016).*

## Mental health among children and youths

The burdens of both stress and mental health problems are increasing in today's society and affect adults and young people all over the globe. In estimates from the Global Burden of Disease study (GBD), it is reported that 14% of children and adolescents aged 10-19 suffer from mental disorders (IHME, 2019). An even higher prevalence of up to 25-30% of common mental disorders has been reported among adolescents in meta analyses based on self-reported symptoms (Silva et al., 2020). A national report from Sweden in 2021 showed an unambiguous increase in mental health problems among Swedish youths during the last 30 years. According to a GBD study, the amount of mental health disorders has been stable over time in Sweden, however, the number of young people being diagnosed with a mental health disorder seems to increase. The consumption of mental health care is increasing in Sweden, yet it is estimated that the unmet need for specialized care is still high. Suicide among young people in Sweden has increased year by year during the last 20 years (Dalman et al., 2021).

Global estimates in studies after the global Covid-19 outbreak in 2020 indicate an increase in mental health problems among young people in the aftermath of the pandemic (Kauhanen et al., 2022), referred to being related to increased social distancing, loneliness, economic stress within the family, increased child abuse, cyberbullying, and concerns around the future, which are all established risk factors for mental health problems among young people and tend to increase in today's society (Kauhanen et al., 2022).

The causes of mental health problems are proposed to be many. Lifestyle factors such as sleeping problems (Qiu & Morales-Muñoz, 2022), poor diet (Dehghan et al., 2022),

insufficient physical activity (Korczak et al., 2017) and increased screen time (Liu et al., 2016) are well-known risk factors associated with mental health problems in youths.

Stressful events in early life are another risk factor for the development of mental health problems such as depression (Ge et al., 2001), especially if the child has or is currently exposed to other stressors such as peer bullying, delinquent peers and low self-control (Gajos et al., 2022). On the contrary, high household income and parental education as well as good parental attachment, collective efficacy, as well as school connectedness showed a lower risk for the development of mental health problems in the same sample (Gajos et al., 2022). Together with other intrinsic factors such as having good problem-solving skills, high aspiration, and goals as well as extrinsic factors such as good family connections and peer support reduces the risk of experiencing and developing mental health and emotional problems and could thereby constitute important and protective resilience factors (Yoon et al., 2022).

Early onset of mental health problems causes troubles in many important aspects of life in both personal, intrapersonal as well as academic performances and achievements (Schulte-Körne, 2016). Development of mental health problems in early adolescence increases the risk for sustained problems into late adolescence (Ge et al., 2001), as well as both mental health problems (Wolitzky-Taylor et al., 2014) and somatic health complaints with an increased burden of disease later in life (Bohman et al., 2018).

It is important to address that mental health problems can manifest in many ways, such as nervousness, worry, rumination and irritability as well as psychosomatic problems such as tiredness sleeping problems, and psychosomatic pain such as abdominal pain or headache. It is important to distinguish between emotional wellbeing and mental health disorders such as anxiety and depression disorders, which do not always overlap (Haworth et al., 2017; Patalay & Fitzsimons, 2016). Further on, it is important to distinguish between mental health problems and mental health disease, which most often requires other treatment strategies and more often medical treatment (Dalman et al., 2021). In Figure 1, a model to describe the relationship between mental wellbeing, mental health problems and mental diseases is described.

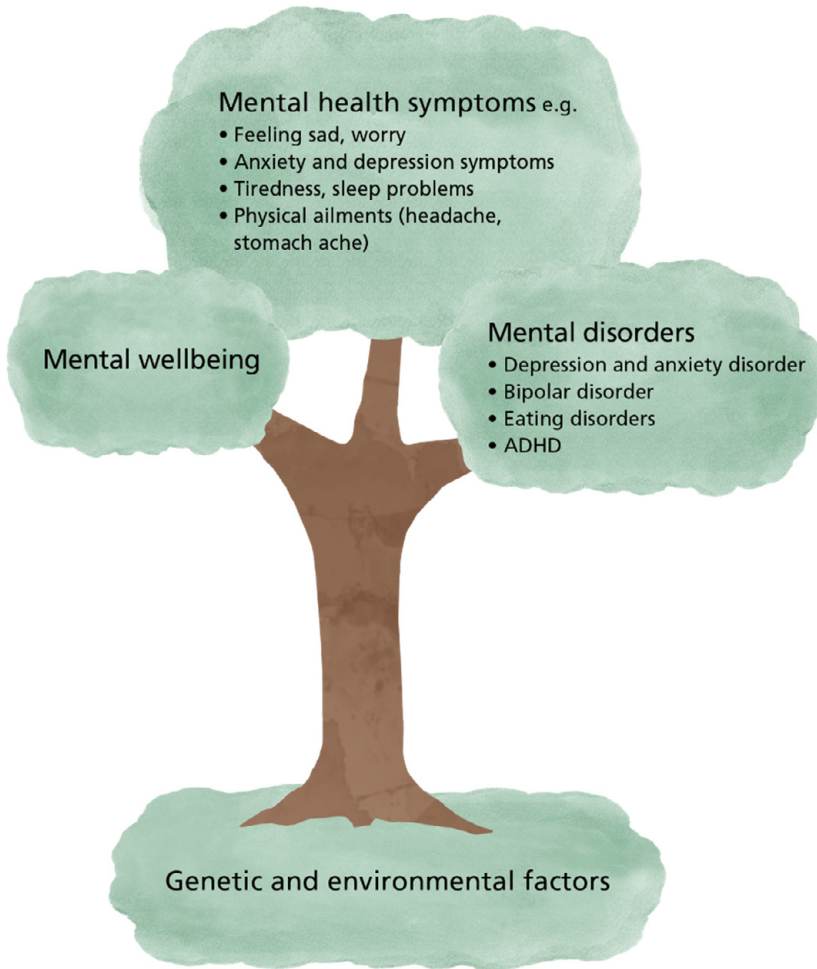
Pharmaceutical treatment is indicated for severe mental disorders solely. Prescription of antidepressant medication, especially selective serotonin reuptake inhibitors (SSRI), to children and adolescents has shown a rise during the last 15 years. The latest report on the use of SSRI in Swedish adolescents showed an increase between 2006-2013 (Lagerberg et al., 2019) and similar trends have been shown in Europe (Dai Cao et al., 2021; Tiffin et al., 2019), even though the use of SSRI has been debated due to the associated increase of suicidal risk (Li et al., 2022), and should not be considered as a first-line treatment (Luxton & Kyriakopoulos, 2022). Prescription of antidepressant

medication was larger among adolescent girls than among boys (Dai Cao et al., 2021; Lagerberg et al., 2019).

Childhood and adolescence constitute a crucial period in life, where social and emotional habits develop and manifest, and many of the factors that contribute to lifelong well-being are, or are not solidified (Ross et al., 2020). This early time in life could thereby be seen as a key period in time to work preventively and to reduce the escalation of mental health problems in future life (Yoon et al., 2022).

The language used to describe mental health problems vary widely across publications, and concepts and definitions of mental health problems are often unclear and overlapping. One reason could be that mental health is discussed in a variety of fields including both medical and non-medical disciplines such as psychiatry and psychology as well as biology, sociology and philosophy (Richter & Dixon, 2022). Another complicating factor when defining mental health conditions is the sometimes fine line between “normal” and pathological mental health symptoms. Most people will experience mental health symptoms without being troubled with a disease or disorder. A disorder is most commonly defined as a collection of signs and symptoms with known associated features that are presumed to be related, whereas disease is defined as an involuntary physiological or biological illness that typically has some underlying cause (Peterson & Keeley, 2014). Mental disorders and mental diseases are always pathologic and most commonly diagnosed by either the DSM or ICD manual. Mental health problems include both mental health symptoms as well as mental disorders and diseases.

In the continuation of this thesis, we will focus on mental health symptoms as clarified in the figure below.



Figur 1. A model to describe the relationship between mental wellbeing, mental health symptoms and mental disorders inspired by the model from Socialstyrelsen (Socialstyrelsen, 2020)

## Gender differences

The gender difference in mental health problems is prominent. Over the last few years, mental health problems have been unequivocally reported more frequently among girls than boys; this has been shown globally (Ge et al., 2001; Schulte-Körne, 2016; Silva et al., 2020; Yoon et al., 2022), as well as in national epidemiologic studies conducted in Sweden (Folkhälsomyndigheten, 2018). Girls use mental health services more often than (Dalman et al., 2021).

Girls present mental health problems earlier in life than boys and tend to increase in symptoms over time (Yoon et al., 2022). Studies among younger adolescents show that gender differences could be seen already in early adolescence, where girls presented higher levels of emotional difficulties and lower subjective wellbeing than boys already at 11-12 years of age (Yoon et al., 2022). Due to recent reports, a gender difference in the presentation of major depression was observed already at age 12 (Hyde & Mezulis, 2020) and peaks at age 13-15 (Hyde & Mezulis, 2020). In addition, girls seem to increase in symptoms during adolescence, whereas symptoms among boys stay fairly stable over time (Yoon et al., 2022).

Furthermore, in the presentation of mental health problems, gender differences can be observed. Internalizing problems such as emotional problems (Yoon et al., 2022) as well as depression (IHME, 2019; Yoon et al., 2022), anxiety and eating disorders are overrepresented among girls (IHME, 2019; Yoon et al., 2022). Boys, on the other hand, present a higher level of externalizing problems such as behavioral and conduct problems as well as hyperactivity/inattention problems than girls (IHME, 2019; Yoon et al., 2022). In Sweden, suicide is more common among boys than girls (Dalman et al., 2021)

However, in general, mental health problems are increasing also in boys during recent years, and reports from 2019 concluded higher estimates of mental disorders among boys than girls aged 10-19 years; 15% vs 12% among 10-14 years and 15% vs 14% among teenagers 15-19 years (IHME, 2019). Boys in Sweden showed a proportionally greater increase in mental health symptoms than girls during the last 20 years (Dalman et al., 2021). It should also be addressed that most studies on mental health problems rely upon self-reported data and questionnaires, which leaves room for potential bias. Over the last decade, new lights have been shed on the presentation of behavioral problems and underlying neuropsychological conditions such as ADHD and autism and how it might shown up differently among girls than boys and thereby tend to be underdiagnosed (Rynkiewicz & Łucka, 2018). This in turn might lead to the manifestation of other symptoms such as internalizing problems and depression when the underlying needs are not met and treated (Rynkiewicz et al., 2019). Boys tend to have a higher stigma around mental health problems, and a lower willingness to seek help and support than girls (Chandra & Minkovitz, 2006; Vogel et al., 2011). Difficulties around articulating emotional problems and needs could contribute to an underestimation of mental health problems among boys.

Even though many attempts have been made to associate gender with mental health problems, conflicting results have been shown when looking at male and female characteristics as risk or protective factors for mental health problems. Girls seem to have a larger tendency towards negative coping styles such as rumination, which is an established risk factor for depressive symptoms among youths (Xia et al., 2022) Some



theories implies that girls might be more vulnerable than boys to gender intensification, meaning to live up to normative gender roles and expectations during puberty (Ge et al., 2001). In comparison with boys, girls also seem to be more vulnerable than boys in regard to pubertal timing. The onset of early pubertal development and menarche are significant risk factors for depressive symptoms among girls (Ge et al., 2001). However, it is still not fully understood whether the increased risk relies upon social norms and behavioral expectations (Ge et al., 2001), sexualism and objectification or hormonal and biological changes. Female discrimination and sexism show a significant and longitudinal association with internalizing symptoms among adolescent girls, and it also affects future gender disidentification with female gender identity (Rogers et al., 2022). Even though both boys and girls experience body dissatisfaction and pressure, this tendency seems to be more prominent among girls. Girls show higher levels of internalizing body ideals and perceived media pressure to achieve those ideals than boys do (Knauss et al., 2007).

Even though it is yet not fully understood, girls and boys present mental health problems differently (Hiltunen, 2017). Given these differences, interventions targeting mental health in adolescents might be adapted differently among boys and girls to meet gender-specific needs at different time points. Two of the interventions in this thesis are focused solely on girls as an attempt to meet some of the gender-specific needs.

## Somatic symptoms

Mental health as well as stress-related problems can manifest in many different forms. It is not uncommon that mental health problems manifests in somatic symptoms and complaints such as tiredness, headache, abdominal pain as well as nausea and palpitations. Having psychosomatic symptoms, such as abdominal pain, early in life increases the risk of sustained pain conditions (Walker et al., 2010) as well as severe mental illness later in life (Bohman et al., 2018). Therefore, it is important to find individuals also with psychosomatic problems early in life to be able to work preventively.

### **Tiredness and sleeping problems**

Sleep is essential for children and adolescents' development, physical and mental health as well as academic performance (Touitou, 2013). Despite this, disrupted sleep patterns and following daytime tiredness are commonly reported among adolescents (Gustafsson et al., 2018b; Kronholm et al., 2015).

The correlation between sleep disturbances and mental health problems among youths is well described (Qiu & Morales-Muñoz, 2022). A bi-directional association between sleep disturbances and anxiety and depression has been observed in systematic reviews of the literature (Alvaro et al., 2013). The relationship between sleeping problems and mental health is not fully understood, but it is not impossible to believe that the same underlying mechanisms play an important part in the manifestation of both issues. In a systematic review of the literature, Blake et al describe the importance of both biological, psychological and social factors such as disruption of the HPA-axis, genetic polymorphism, cytokine and inflammatory functions as well as rumination, worry, and overall intrapersonal and family stress as common factors for both mental health problems and sleeping problems (Blake et al., 2018).

Sleep disturbances in childhood predicted the later development of anxiety and depression symptoms (Alvaro et al., 2013). A strong correlation was observed between high night awakening frequency and mental health problems among teenagers aged 13-14 years old in a large sample of 11,553 individuals born in the UK. Hyperactivity and inactivity were significantly associated with disturbed sleep patterns. Gender differences were shown in the sample, where girls with insufficient sleep had a higher prevalence of internalizing and emotional problems, whereas boys with insufficient sleep showed a higher prevalence of externalizing and behavioral problems (Qiu & Morales-Muñoz, 2022).

### **Functional abdominal pain**

Recurrent abdominal pain is a major problem among children and adolescents, with a prevalence of up to 16% dependent on what diagnostic criteria are used (Kortterink et al., 2015). To better describe and classify childhood and adolescent functional abdominal pain disorders (FAPDs), can be defined using the Rome IV criteria, and divided into the following subcategories: functional dyspepsia, irritable bowel syndrome, abdominal migraine and functional abdominal pain not otherwise specified (J. S. Hyams et al., 2016). It is not uncommon that different FAPDs coexist. The diagnoses are symptom-based and can be used first after a proper medical evaluation has been made, and no other underlying medical condition can be attributed to the symptoms (Jeffrey S Hyams et al., 2016).

Abdominal pain constitutes a major burden for both children and families, associated with lower quality of life (Ayonrinde et al., 2020) and school absenteeism (Saps et al., 2009; Youssef et al., 2008). Functional abdominal pain syndromes do not seldom overlap with other pain disorders, as well as psychological and psychiatric syndromes especially anxiety, depression, and somatization syndromes (Ayonrinde et al., 2020;

Mayer & Tillisch, 2011). In addition, being troubled with abdominal pain early in life increases the risk of sustained pain conditions (Walker et al., 2010) as well as severe mental illness later in life (Bohman et al., 2018).

As of yet unknown reasons, abdominal pain is more commonly reported among girls (Ayonrinde et al., 2020; Korterink et al., 2015; Thapar et al., 2020).

The causal mechanism underlying FAPDs are not fully understood (Jeffrey S Hyams et al., 2016). One of the major theories suggests that the cause includes a dysregulation of the brain-gut axis (Camilleri & Di Lorenzo, 2012; Mayer & Tillisch, 2011; Thapar et al., 2020). The bi-directional communication between the brain and the GI-tract play an important role in the regulation of many vital bodily functions as well as disease. The brain receives a constant stream of interoceptive input from the GI-tract, and when integrated with input from other parts of the body, as well as sensory input from the environment, the brain sends a response back to various target cells within the GI tract. Normally, most of these signals are not consciously perceived, but work primarily as an autonomic reflex pathway. In patients with functional abdominal pain disorders, conscious perception of these processes can be experienced as pain or discomfort. In addition, this is often associated with alterations in autonomic nervous output as well as with emotional changes (Mayer & Tillisch, 2011).

Another theory, which further strengthens the link between recurrent abdominal pain and dysregulation in the nervous system, is the observation of an enhanced startle-reflex response to auditory stimuli and a higher resting muscular activity in abdominal muscles (Alfvén et al., 2017; Bakker et al., 2010). This has been demonstrated in two small, controlled studies including children and adolescents aged 8-17 years (Alfvén et al., 2017; Bakker et al., 2010). Evidence needs to be strengthened for further knowledge and potential use in clinical practice.

It is well described that the child or adolescent coping strategies for experienced pain and stress greatly influence the outcome of the pain condition as well as the maintenance of the syndrome, functional disability, and psychological distress (Walker et al., 2010). Passive coping, meaning low acceptance and little ability to confront the pain, social withdrawal, and beliefs that the pain is not able to reduce is associated with higher levels of episode-specific symptoms, emotional distress, as well as negative long-term outcome whereas adaptive and active coping strategies where the child uses self-encouragement and accepts their pain, are more likely to decrease symptoms in both short- and long-term outcomes (Walker et al., 2010). This theory was further developed when investigating how exposure-based internet cognitive behavioral therapy could be used as a potential treatment for children and adolescents with FAPDs (Lalouni et al., 2021; Lalouni et al., 2016) A reduction of avoidance behavior was seen

to mediate the effect of the CBT program in both children and adolescents (Lalouni et al., 2021; Lalouni et al., 2016). This further strengthens the hypothesis that healthy coping strategies might be an important factor in the management of FAPDs.

Overall, the wider understanding that the underlying cause of FAPDs is multifactorial, including both physiological changes as well as psychological, stress-related as well as pain perception and coping strategies expands the arena of treatment options. In addition to pharmacological treatment, which in general has low evidence (Rexwinkel et al., 2021), over the last decade different cognitive, behavioral as well as psychosocial (Gordon et al., 2022; Santucci et al., 2020) treatment options have been tested and shown to be effective as treatment options for pain syndromes such as FAPDs. CBT as well as hypnotherapy (Abbott et al., 2017; Gordon et al., 2022) have also shown promising results. In addition, the interest in using yoga as an alternative treatment option is growing, even though the scientific evidence is still scarce (Abbott et al., 2017; Gordon et al., 2022).

*”Jag kom dit med tillräckligt ont i magen för att inte ha någon lust att komma dit och lagom till avslappningen hade det släppt så det var bara lugnt å skönt igen, så mitt i dansen så kände jag ”Nu, nu släppte det” så då kändes det att det var rätt värt å gå hit idag, det var det.”*

*(I came to the dance with enough pain in my belly to not feel like going there at all, but at the time of the relaxation it was gone and then it felt good again, and in the middle of the dance I felt “Now its gone” and then it felt kind of worth to go there, it certainly was)*

*Quote from one of the girls in the Just In TIME project*

# Resilience

Resilience could be defined as the individual's capacity to maintain and regain mental health and wellbeing, as well as the ability to bounce back from challenging life events and adversity and to adjust positively. An individual's resilience is dependent upon the person's biological, societal, and environmental factors, and has the possibility to be strengthened over time. Clinical and public health interventions can have a great impact in building and strengthening resilience, especially for young and vulnerable people (Herrman et al., 2011). Resilience is positively associated with psychological wellbeing in adolescents (Haddadi & Besharat, 2010). In addition, psychological wellbeing is influenced by the adolescents' self-esteem, personal competence, tolerance of negative affect as well as spirituality (Haddadi & Besharat, 2010), which thereby could be seen as resilience factors.

## Universal and targeted interventions

*Rädda dig själv, skatt.  
Vänd dig sedan om och se.  
Hur världen följer.*

*(Save yourself, my love.  
Then behold as the whole world.  
Tread in your footsteps.)  
- Victoria Palm*

One of the greatest challenges in promoting mental health and preventing mental health is to utilize scarce resources and to target the right individuals, at the right time, with the right interventions. The National Academy of Medicines in the United States defines primary prevention as universal, selective, and indicated prevention, depending on how and for whom the intervention is performed (National Research Council and Institute of Medicine Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, 2009). Universal prevention addresses a whole population, not defined on the basis of risk, such as a whole school, school class or community. This intervention has the potential to reach out to a large group of people at once without the selection or screening of individuals in advance.

The advantage of universal interventions is that individuals who would otherwise risk going under the radar and fall between the cracks also can be reached. The downside, however, mainly consists of the generalization of the interventions that need to be done and if the intervention is not well planned and well thought out there is a risk that the intervention becomes a “one size fits all” and eventually becomes too generalized to fit anyone at all (National Research Council and Institute of Medicine Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, 2009). It is also possible that universal interventions do not allow for individuals who are feeling insecure to obtain enough space in a big group with more secure individuals, and that those individuals with needs thereby risk being pushed aside.

The school environment is an important arena for children and adolescents’ mental health. Research implies that the risk of developing mental health problems can be reduced by changes in the school environment, and by the implementation of evidence-based methods for at risk individuals (Schulte-Körne, 2016). Systematic reviews have shown positive effects of universal school-based resilience-focused mental health programs including mindfulness, for children aged 5-12, in regards to stress-coping skills (Fenwick-Smith et al., 2018), anxiety, depression and psychological distress and in adolescents in regards to internalizing problems (Dray et al., 2017). Teacher engagement and the possibility to adapt the program in accordance with the students in the room were highlighted as key factors for a positive outcome in these interventions (Fenwick-Smith et al., 2018).

However, despite the suggestion that school constitutes an appropriate setting for improving and protecting mental health among students, few studies with health economic calculations have been performed (Schmidt et al., 2020). In general, universal methods of anxiety and depression prevention were not considered cost-effective (Schmidt et al., 2020). However, the review mostly included CBT-based programs. On the other hand, the room for improvement is lower in a group where the baseline values of mental health symptoms are generally high. This is often referred to as the “ceiling effect” and has been cited as a potential limitation in the interpretation of results in universal studies (Fenwick-Smith et al., 2018; Schmidt et al., 2020).

In contrast to universal programs, cost-effectiveness has been documented in targeted interventions (Mihalopoulos & Chatterton, 2015), which most often focus on those individuals at the highest risks and needs. Targeted interventions can be performed as selective or indicated prevention, where, due to the National Academy of medicines definitions, selective prevention is targeted at subgroups with a higher-than-average risk of developing mental disorders, and indicated prevention is targeted at subgroups with high-risk individuals or individuals with detectable but subclinical symptoms of a mental disorder. These interventions can be designed in a manner that are more tailor-

made for a specific condition or risk (National Research Council and Institute of Medicine Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, 2009).

While universal programs might be of better use in the promotion of mental health, targeting selected individuals in certain risk groups might be of better use in the prevention of mental problems. Herein lays the challenge of finding the right individuals, which means a selection process, and a potential time-consuming effort. There is also an underlying risk that all individuals with needs might not be reached and fall between the cracks (National Research Council and Institute of Medicine Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, 2009). Targeted interventions are also more challenging to include in an ordinary school schedule, which creates a bigger challenge for the individuals participating, and tends to build on external pressure on the individual and the family.

In this thesis, two of the interventions were delivered as targeted interventions, and one intervention was delivered with a universal approach. In the universal intervention, subgroup analyses on groups with different characteristics were performed in the analyze process.

## How to investigate mental health in adolescents and children?

There are many ways to measure mental health among adolescents and children, including questionnaires, interviews or register data (Dalman et al., 2021). Questionnaires are designed to measure general mental health problems or disorders and they can provide detailed information. However, they are often extensive and require time and resources to complete. Furthermore, credibility can be negatively affected if the response rate is low. Using register data is more efficient in the case of resources, but they do not provide the same nuanced picture as questionnaires. In addition, many people do not seek health care and thereby the hidden number could potentially be high (Dalman et al., 2021).

Evaluating mental health problems relies on self-reported data, which can be answered by the individual themselves or by teachers, parents, or other caretakers. Due to the risk of recall bias, and the ability to self-reflect, the value of self-reports from younger children has been questioned. However, self-reports have shown valuable information with a clinical and scientific value from the age of 8 as long as the questionnaires used are age-adapted (Rebok et al., 2001; Riley, 2004). Low agreement between teacher and

parent reports in the assessment of mental health symptoms, at least for children aged 5-10 (Brown 2006), further justifies children's own reports. Validated or commonly used questionnaires and formats enables comparison with larger populations nationally or internationally (Lindén-Boström & Persson, 2009). Validated scales such as Beck Youth Inventory, BYI (Beck, 2001; Beck et al., 2001) are commonly in research or in large sample screening (Basker et al., 2007; Thastum et al., 2009). However, these scales hold a low value as diagnostic tools in clinical practice when evaluating depression and anxiety. It should also be addressed that anxiety symptoms often present in a wide range of psychopathology, and can thus be difficult to differentiate from each other (Thastum et al., 2009). Evaluating pain and somatic symptoms are preferably done using visual scales such as Visual Analogue Scale or Faces Pain Scale (FPS-R) (Hicks et al., 2001; Huguet et al., 2010; Tomlinson et al., 2010) scored 0-10.

In contrast to subjective data, objective measures play a smaller, however important role in the investigation of mental health. To date, there has been no use of specific blood samples or genetic testing in use for the assessment of mental health outcomes. Sampling of cortisol has been extensively used as a marker for stress (Hellhammer et al., 2009; Ryan et al., 2016), and can be measured in saliva, blood, or hair, even in very small children aged 12-60 months (Bates et al., 2017). Sleep assessment as a secondary or complementary measure of mental health can be done using self-reports such as Pittsburgh Sleep Quality Index, also validated among children (Scialpi et al., 2022), and using objective measures such as EEG (Sadeh, 2015).

Over the last years, the fast development of fMRI together with machine learning opens the possibility to measure brain structure and real-time brain activity and provides a whole new arena of objective measures of mental health, with a widened perspective of physiology and pathophysiologic understanding (Taschereau-Dumouchel et al., 2022). However, all objective measures provide limited information when not complemented with information about the patients' experience.

Qualitative interviews with thematic or content analyses provide a wider view of the patient's own experience (Crowe et al., 2015), and can also be performed with adolescents and children (Michelle & Parker, 2014). In this way, children and adolescents' own voices can be heard, which provides invaluable information that is impossible to capture in numbers or any other measures.

Investigating mental health from different perspectives provides a fuller and more comprehensive picture of the condition, whereas using narrower and more specific sets of outcome gives information that is easier to generalize and compare with other studies in the field. In this thesis, mental health is observed from a variety of outcomes,



including subjective and objective measures of direct and indirect measures of mental health.

Since cortisol in saliva was used as an objective measure in the Just in TIME project, and the BECK scale were used as subjective measures in the Mindfulness project, these methods are further described below.

## **BECK**

The Beck Youth Inventory consists of self-report measures which assess the perception of self-concept, disruptive behavior, anxiety and depression. Beck Depression and Beck Anxiety focuses on depression and anxiety symptoms solely (Beck, 2001; Beck et al., 2001). Beck Anxiety Inventory (BAI) includes items that reflect the worrying, fear and other psychological symptoms of anxiety. Beck Depression Inventory (BDI) covers items regarding the children's feelings of sadness as well as negative thoughts about themselves, their lives and their futures and other psychological indicators of depression (Beck, 2001; Beck et al., 2001). Each inventory consists of 20 statements, where the respondent rates their experience of agreement on a 4-point scale from the following: 0=never, 1=sometimes, 2=often, 3=always). Each inventory is scored by adding the 20 ratings. The full inventory takes around 10 minutes to complete (Beck, 2001; Beck et al., 2001). The BDI has shown satisfactory internal consistency and test-retest reliability among adolescents (Basker et al., 2007; Thastum et al., 2009), and has been suggested as a useful screening instrument in school settings (Thastum et al., 2009).

## **Cortisol – the stress hormone**

*Stress is not always something bad,  
it just means that you actually care  
– Henrik Lennartsson*

Cortisol is one of the major stress hormones in the body, reflecting the activity of the Hypothalamus pituitary adrenal axis (HPA-axis) (Hellhammer et al., 2009). In addition to being an important stress hormone, cortisol also plays an important role regarding growth, development, and maturation of the brain, which implies the importance of healthy cortisol, especially in childhood (Adam et al., 2017). The release of cortisol follows a daily diurnal pattern, with high secretion during the morning, and

a reduction during the day (Herman et al., 2016). In healthy individuals, cortisol is also released in a certain amount as a response to acute stress. The secretion of cortisol is affected by long-term stress, where the acute secretion might be increased or decreased (Foley & Kirschbaum, 2010). Due to lower secretion of cortisol during the mornings, and overall higher values during the day and the evening, the diurnal curve is flattened (Morelius et al., 2013). Changes in cortisol secretion over time are associated with negative health outcomes and the development of disease (Adam et al., 2017). It has also been shown that an inadequate release of cortisol at the time of an acute traumatic event increases the risk of the development of post-traumatic stress disorder (Mouthaan et al., 2014).

Measuring cortisol can be performed in different ways and depends on the wish to measure long-term or short-term stress response. Cortisol in saliva directly reflects the concentration of cortisol in blood and gives a direct snapshot of actual in-moment cortisol levels (Hellhammer et al., 2009). This can be performed as a single value or performed over the duration of one or more days and thereby calculate the diurnal slope. Cortisol in hair reflects the average cortisol levels over the last couple of months, it gives no information on the daily fluctuations or acute response in the HPA-system, but tells if the individual has chronic high, low or medium cortisol levels over time (Bates et al., 2017; Manenschijn et al., 2011; Michaud et al., 2022).

It should also be mentioned that cortisol secretion shows a great intraindividual variability, and that should always be taken into account when interpreting cortisol data (Hellhammer et al., 2009).

# Theoretical framework

*Du kan aldrig ta bort mörkret,  
men du kan alltid tända ett ljus*

*(You can never take away the darkness,  
but you can always bring in some light)*  
- Anna Duberg

Dance, yoga, and mindfulness may seem like three different interventions. However, all the interventions share some important factors that can be integrated in a common theoretical framework. In addition to a non-judgmental, compassionate mindset, mindful awareness and embodiment, all interventions contain important strategies for improved self-regulation such as breathing and relaxation. In this section, I will first describe the main common denominators of the three interventions, followed by a description of dance, yoga, and mindfulness separately.

## Self-regulation

Self-regulation could be defined as the individual's capacity to control their behavior, thoughts and emotions in order to achieve their goals, including controlling impulses and constructive problem-solving and actions (Murray et al., 2019). Self-regulation depends on multiple factors and their interplay, including behavioral skills such as impulse control and stress control, cognitive skills such as self-reflection, self-monitoring and problem solving and emotional skills such as acceptance and awareness of emotions, tolerating physical and emotional distress, self-calming strategies, and empathy (Murray et al., 2019). It could be further described as a balance and interplay between consciously controlled regulatory "top-down" processes" often referred to as executive functioning which includes cognitive flexibility and inhibitory control, and the less intentional and reactive, sometimes called "bottom-up" processes such as anxiety and arousal (Murray et al., 2019).

A person's self-regulation skills are strongly correlated with the individual's socioemotional functioning as well as cognitive functioning and psychological health (Murray et al., 2019). Self-regulation is of importance during an individual's whole life but plays an especially important role during childhood and adolescence; a period which reflects a time with substantial self-development and development of self-regulation skills (Murray et al., 2019; Zelazo & Lyons, 2012). Evidence shows that self-regulation skills in childhood and adolescence not only play an important role in school achievements and performance, as well as emotional (Murray et al., 2019) and psychological wellbeing (Fomina et al., 2020), but also predict the maintenance of healthy behaviors (Weidner et al., 2016), physical health, substance dependence, socioeconomic status and the likelihood of criminal conviction, independent of social class or IQ (Moffitt et al., 2011).

Self-regulation is a skill that develops during the lifecourse. Its development during childhood and adolescence is influenced by multiple biopsychological factors. In addition to the ability to develop intrinsic self-regulation skills, it is also strongly dependent on a supportive environment, warm and responsible relationships as well as co-regulation from adults and caretakers (Murray et al., 2019). Humans are social beings, and due to the polyvagal theory, which was first described by Porges in 1985, feeling safe in a group enhances co-regulation and develops calmness and downregulation of the autonomic nervous responses that decreases stress (Porges, 2022).

Stressful environments and relationships clearly affect the development of self-regulation. Long-term stress can negatively affect self-regulation skills by increasing emotional reactivity causing faster and more intense emotional reactions to acute stress or over-reactivity to, in general, small stressors that would otherwise be perceived as benign (Murray et al., 2019). Growing up in an environment with high levels of stress puts a higher demand on self-regulation while at the same time impairing the self-regulation development process (Murray et al., 2019).

The "Top Down" processes reflect the higher brain functions often referred to as executive functioning including cognitive flexibility and inhibitory control, whereas the "Bottom-Up" processes reflect the less intentional and reactive processes such as anxiety and arousal (Murray et al., 2019). Under the influence of stress, subcortical limbic structures including the amygdala, interferes with the ability to access higher brain functions, often resulting in being overwhelmed. On the other hand, an increased ability to stay present and to self-reflect by consciously addressing what is thought and felt can help interpret intense emotional states and thereby lessen their intensity (Music, 2014; Van der Kolk, 2016). The ability to use magnetic resonance makes it possible to further study emotional regulation and resilience and the associated brain structures. Even though still not fully understood, it is found that resilient individuals seem to

have increased gray matter volumes in the hippocampus, prefrontal cortex and anterior cingulate cortex, areas involved in higher brain functions that play an important role in the downregulation of the amygdala and associated stress responses (van der Werff et al., 2013).

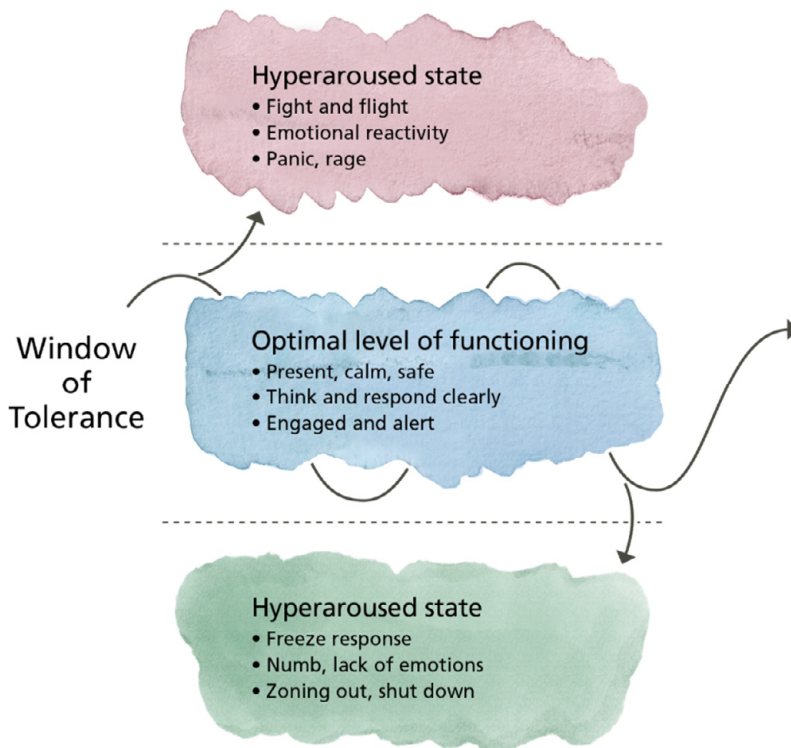


Figure 2. An illustrated model describing the “Window of tolerance” inspired by the model of Milton, Odgers and Pain (Minton et al., 2006)

Another way of describing this phenomenon is to refer to the “Window of tolerance” model most often talked about within trauma research, however applicable among all individuals (Gray, 2016; Van der Kolk, 2016). The window of tolerance constitutes the individual’s ability to cope with stress. Being stimulated out of this window causes hyper- or hypoarousal where the individual goes into threat and fear responses. This puts the individual either in a hypervigilant fight-and-flight state accompanied by

feelings of anxiety and panic, or a freeze response, which more often is accompanied by feelings of “shut down”, emotionally numbed, fatigue or even depression (Minton et al., 2006). Long-term stress or trauma narrows the window of tolerance, where the ability to stay regulated becomes smaller, and even apparently small stimuli can cause intense and dysregulated emotions and feelings. A healthy self-regulation consists of a wider window of tolerance, and a better ability to cope with otherwise stressful stimuli. Self-regulation goes hand-in-hand with the window of tolerance, and with better self-regulation skills the window of tolerance can increase over time (Van der Kolk, 2016).

In conclusion, self-regulation skills develop during an individual’s whole life but play a particularly important role during childhood and adolescence. It could be defined as the individual’s responsiveness to stress and the ability to handle emotions, stressful stimuli and form relationships (Murray et al., 2019). Co-regulation in safe relating to others is important in the development of self-regulation (Porges, 2022).

The following sections continue to describe important aspects of self-regulation, and how the different methods in this thesis including dance, yoga and mindfulness affect and enhance important skills in the development of healthy self-relation skills.

## Looking into the nervous system

*Sluta vara en isflakshoppare!*

*(Stop jumping from ice floe to icefloe!)*

*– Mats Bjurgren*

To further understand the theoretical framework and basic physiology we will start by taking a closer look at the autonomic nervous system. The autonomic nervous system functions without voluntarily or conscious control and plays a crucial role in the maintenance of homeostasis within the body. (homeostasis = maintaining a balanced internal environment) (Modell et al., 2015). The nervous system innervates smooth muscles, cardiac muscle, the gastrointestinal tract as well as exocrine and endocrine glands and thereby influences the activity of most tissues and organs in the body. The regulation of blood pressure, heart rate, gastrointestinal response to food as well as

thermoregulation are just a few of many physiologic functions regulated by the autonomic nervous system (McCorry, 2007). The regulation of the autonomic nervous system is mainly by autonomic reflexes from sensory input from viscera in the body, but also by higher brain structures. Specifically, the cerebral cortex and the limbic system play a vital role in the autonomic responses to emotional stimuli such as blushing during an embarrassing moment, or increased heart rate during emotional stress.

To further increase the ability to a more precise regulation of bodily functions, the autonomic system is composed of two anatomically and functionally distinct divisions - the sympathetic and the parasympathetic system - with apparently opposite effects on tissue function. The sympathetic nervous system is activated during activity and exercise and is often referred to as the “Fight and Flight” system. This involves an enhanced activity mainly of blood vessels and increased cardiac output and an increased release of stress hormones such as epinephrine and norepinephrine as well as cortisol (McCorry, 2007). This plays a vital role when preparing an individual for activity, however, when activated during anxiety it can give rise to bodily experiences such as palpitations, diarrhea, constipation, and abdominal discomfort. The autonomic reaction to psychological stress plays a vital role in psychosomatic disorders and stress-related somatic symptoms (Ziegler, 2012).

The parasympathetic nervous system predominates under quiet conditions, often referred to as the “Rest and Digest”, and mainly influences the conservation of energy, restoration of bodily functions and digestion and increased motility of the gastrointestinal tract (McCorry, 2007). The vagus nerve is the main nerve in the parasympathetic nervous system, including both afferent (sensory) inputs and efferent (motor) inputs (Karemaker, 2017). Heart rate variability (HRV), meaning the beat-to-beat variability of the heart rate, is a non-invasive measure that can give an estimate of the vagus nerve regulation of cardiac activity. Even though it has some limitations, it is currently one of the most used measures to get an estimation of vagal tone and parasympathetic activity (Karemaker, 2022; Laborde et al., 2017).

# Interoception

*A label is a mask life wears. We put labels on life all the time. 'Right,' 'wrong,' 'success,' 'failure,' . . . Labeling sets up an expectation of life that is often so compelling we can no longer see things as they really are. This expectation often gives us a false sense of familiarity toward something that is really new and unprecedented. We are in a relationship with our expectations and not with life itself.*

— From the book “Kitchen Table Wisdom” by Rachel Naomi Remen

Interoception is the process of receiving, accessing and interpreting internal bodily signals, and involves an iterative process requiring an interplay between the perception of body states and cognitive appraisal of these states (Farb et al., 2015). It could be further described as the integration of bottom-up signals from the body and the top-down cognitive interpretations, thus enhancing body knowing and the experience of body ownership (Seth, 2013). It also plays an important role in being able to track and regulate one’s own internal state and thereby contributes to a wider understanding of the self, emotions, attention as well as empathy and cognitive control (Seth, 2013).

Many body-based practices, and mindfulness and yoga especially, help the individual to feel and be aware of what is happening in the body, which plays a crucial part in developing interoceptive awareness. Together with a non-reactive mindset, the individual can stay present with what is felt and experienced. This mindset can allow an opportunity to see and gain an understanding about the most dominant and learned appraisal tendencies, but also alternative appraisal options that involve larger flexibility of choice over time. Knowing what is felt and consciously choosing a response and appraisal technique allows for the development of more sustainable coping strategies (Farb et al., 2015).

Understanding interoception from a neurophysiologic perspective is ongoing and still to be covered in future research, however, activity in insula and anterior cingulate cortex in the brain seems to play a crucial role in both adults as well as children and adolescents (Klabunde et al., 2019). Noteworthy, these are brain regions frequently covered in research investigating neuroanatomical responses of yoga and mindfulness interventions (Lazar et al., 2005; Sharp et al., 2018; Villemure et al., 2014). In a small study among adult yoga practitioners, increased cortical thickness in insular regions was associated with greater pain tolerability and was stated as a result of interoceptive awareness (Villemure et al., 2014).



Interoceptive awareness and disposal mindfulness is closely associated and independently associated with enhanced psychological wellbeing (Hanley et al., 2017).

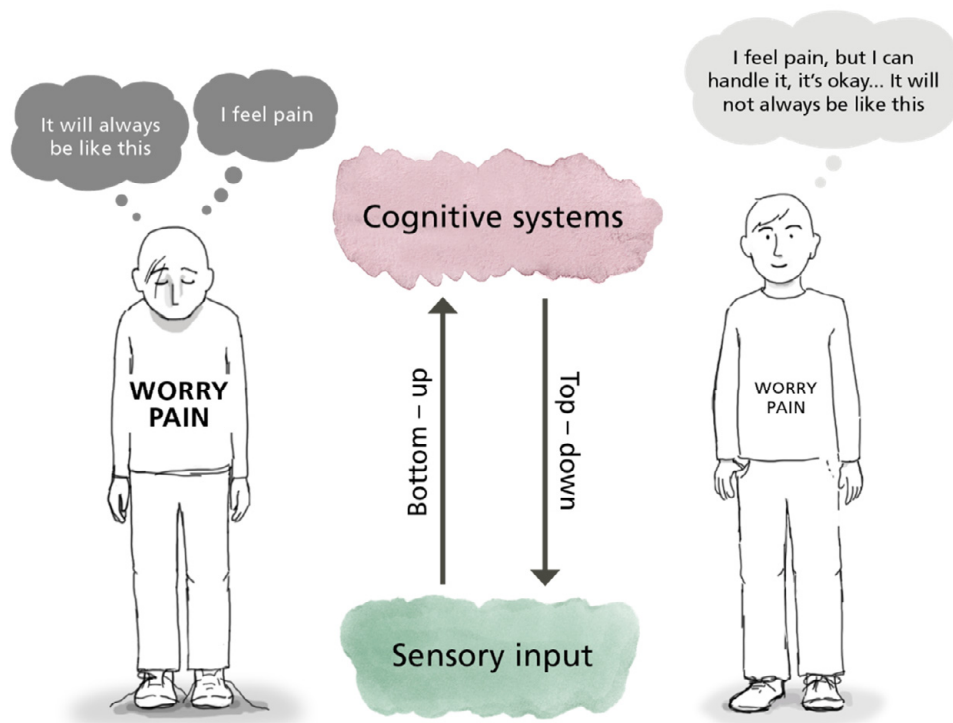


Figure 3. A model made by the author, describing interoception and how cognitive awareness (top-down) processes can influence and downregulate sensory input (bottom-up) and thereby gain body ownership.

## The essential role of breathing

Breathing is an important core element in many relaxation techniques as well as yoga and mindfulness. It is a vital process that functions automatically during day and night; however, it can also be voluntarily controlled. Breathing techniques play an important role in many meditative and relaxation practices and have lately been highlighted in the scientific field because of its effects on the nervous system. Slow breathing has been associated with relaxation, well-being and emotional balance (Jerath et al., 2015), whereas fast breathing more commonly is associated with stress and anxiety (Homma & Masaoka, 2008).

Slow breathing at a pace of six breaths per minute has been shown to positively influence HRV, suggested to be an effect of enhanced vagal stimulation and parasympathetic activity (Laborde et al., 2022; Zaccaro et al., 2018). In a meta-analysis of published data, Laborde et al found positive effects on HRV both during and after interventions with breathing exercises among healthy adults, indicating a long-term effect and a potential chronic increase of vagus nerve efferents (Laborde et al., 2022). In addition to enhanced HRV, Zaccaro et al, referred in a systematic review to enhanced activity in the central nervous system with an increased alpha wave and decreased theta wave activity during slow pace breathing, and associated effects in psychological effects such as reduced anxiety, depression, and anger (Zaccaro et al., 2018).

To enhance the effect of breathing exercises, it can be accompanied with biofeedback. Positive effects were observed in a study involving children where increased HRV, reduced anxiety and social stress were seen after a five week intervention in a school setting (15 min session once/week), including slow-paced breathing with biofeedback. No effects were seen in the control group (Aranberri-Ruiz et al., 2022). Similar effects were seen in a small study including children and adolescents aged 10-17 years with chronic pain, where breathing exercises accompanied with biofeedback showed a decrease in pain intensity and higher levels of self-reported school functioning after a four week intervention (Yetwin et al., 2022).

## The social impact

*We are not the survival of the fittest.  
We are the survival of the nurtured.  
– Louis Cozolino*

Humans are social beings, and the importance of creating healing spaces within groups and communities has been known for a long time. The importance of social support as one of the greatest resilience factors for the maintenance of both physical and mental health was revealed decades ago when Aron Antonovsky described Sense of Coherence, (Antonovsky & Sagy, 1986), and continued to gain scientific value since then, in both human and animal studies. Some animal studies have shown that rats prefer social interactions prior to intake of heroin and methamphetamine, even in highly addictive subjects (Venniro et al., 2018), and that tumor growth progressed more rapidly among

socially isolated rats than rats in a group after injection breast cancer cells (Madden et al., 2013).

Since group interventions address some of the most primal basic needs such as cohesion, being part of something larger, empowerment and building mutual trust (Rutan et al., 2014), the therapeutic role of the group should not be underestimated. In addition, the ability to co-regulate within a group, as described earlier (Porges, 2022), is one of the important factors.

Loneliness and a lack of sense of belonging are important risk factors for mental health problems (Arslan, 2021; Loades et al., 2020). Healthy peer relations were closely associated with young people's subjective wellbeing and reduced the chances of experiencing emotional problems among young people (Yoon et al., 2022). In contrast to individual psychotherapy, interventions performed in a group setting hold the potential to increase social bonds and support the building of peer support. The positive role of the social context has been further highlighted in studies with physical activity among adolescents, where activities performed in a group context showed a greater effect on mental health were further strengthened when the activity was performed in a group setting compared to activities that were performed individually (Doré et al., 2016; Kleppang et al., 2018). Team sports had a greater effect on reduced depression symptoms, whereas other organized activities had a smaller effect (Doré et al., 2016). In a cross-sectional study including a large sample of adolescents, a significantly lower odds for depression symptoms were observed when activities were performed in a social context such as a sports club or organized group classes (Kleppang et al., 2018), which further implies that the social context is of great value in the effect of physical activity in relation to mental health symptoms.

## Self-determination theory

*And it's, like, after ten years you're pretty tired of always being by yourself, doing nothing and like, hanging around at home. And suddenly you're seeing friends who actually seem to want to spend time with you and then it's a whole different thing—you start to develop as a person. So you find yourself in a whole new situation.*

—S2

*Quote from one of the participants in the dance project (Duberg et al., 2016)*

Embedded in human nature is an inherent curiosity, inquisitiveness, and willingness to learn. This phenomenon can be referred to as intrinsic motivation; the most fundamental aspect of maintenance and a sense of joy and individual autonomy. In contrast, motivation can also be stimulated by external factors, which relate to outer demands or pressure to perform, such as gaining reward or avoiding punishment. Stimulating intrinsic motivation is fundamental for adherence and endurance through any kind of action or intervention (Ryan & Deci, 2000). The self-determination theory (SDT) is an approach to human motivation and highlights three basic needs to enhance intrinsic motivation; competence (optimal challenge), relatedness (feeling connected to others) and autonomy (feeling that the work is performed by own will) (Ryan & Deci, 2000). As a way to foster intrinsic motivation and thereby adherence, SDT was used as a framework when planning and conducting the dance and yoga interventions.

# Interventions

## Dance

*When you dance, you can enjoy the luxury of being you*  
— Paulo Coelho

The health benefits of physical activity among children and adolescents are well described and promote a wide range of physical, mental, and social benefits (Bull et al., 2020). Despite this the majority of adolescents aged 11-17 years old do not meet the WHO recommendations of at least 60 min of daily moderate-vigorous activity (Bull et al., 2020; Guthold et al., 2020). And this is especially common among girls (Guthold et al., 2020).

Dance is a popular activity among females (O'Neill et al., 2011) and shares the same health benefits on physiologic measures as regular exercise in regards to cardiovascular fitness (VO<sub>2</sub> max and maximum heart rate) and has even been proven superior to regular exercise in terms of improved musculoskeletal function such as mobility and balance (Fong Yan et al., 2018). Activities that are enjoyable, diverse, non-competitive, and feasible to perform with friends have been shown to foster positive attitudes toward physical activity among girls (Martins et al., 2015). Dance interventions share these characteristics and thereby hold the potential to lower the barriers to engagement in physical activity in this group (Koch et al., 2019; Tao et al., 2022).

In addition to the regular health benefits of physical exercise, dance includes several important core elements that distinguish it from other physical activities (Schwender et al., 2018; Tao et al., 2022). Dancing together in a group as a way to foster healing, celebration, group connectedness and pleasure has been done since ancient times. However, first in the 1980s, dance became popular in research and trials were done to start crystalizing its potential healing effects (Claire, 1985). Already then, themes such as synchrony, expression, rhythm, vitalization, integration, cohesion, education, and

symbolism were described and created a foundation for future scientific reports and research studies of dance interventions (Tao et al., 2022). The holistic approach of dance as an art and therapy form addresses a variety of aspects and effective ingredients such as pleasure and play without goal orientation, aesthetic expression and the experience of beauty and body-mind unity, as well as authentic expression and non-verbal communication with possibilities to create meaning-making and social interactions beyond words (Koch, 2017). Other important aspects of dance involve the internal processes such as meditative awareness, introspection and focus (Bräuninger, 2014), as well as supporting behaviors with a gain of internal and societal sustainability (Bojner Horwitz et al., 2022).

In a recent meta-analyse covering the field of dance interventions and dance movement therapy (DMT), DMT improved affect-related psychological conditions such as anxiety and depression as well as improved quality of life and cognitive skills. Dance interventions showed improvements in motor skills (Koch et al., 2019). In a further systematic review, dance interventions were shown to be beneficial in the management of chronic pain syndromes (Hickman et al., 2022). Dance interventions among adolescents and youths have been shown to increase psychological wellbeing (Burkhardt & Brennan, 2011) improved self-esteem, self-trust and self-expression (Schwender et al., 2018) as well as a decrease in stress related symptoms and emotional distress (Duberg et al., 2020). Dancing together also strengthens social bonds, relating and peer support (Staiano et al., 2018). Some of these positive findings could be linked to an enhanced awareness of emotional processes and increases the ability to interpret the emotions of others that have been described among participants after attendance to a dance intervention (Bojner Horwitz et al., 2015). This was further strengthened in the analysis of qualitative interviewing of adolescent girls after participation in a dance intervention where the girls described a greater sense of belonging and togetherness, as well as enhanced feeling of safety within one's own body as well as in the group (Duberg et al., 2016).

Moving together - alone or in a group - guided by music and rhythm allows self-expression through the body and enhances interconnection between people (Kaufmann, 2011). Following the same rhythm can break down the barriers of communication and allows for strengthening coherence within a group. By observing the effects on children with adverse traumatic experiences, the use of music and rhythm facilitated a sense of pleasure, satisfaction, inner peace, and safety within the group (McFerran et al., 2022). This supports co-regulation between individuals where stress can be lowered by suppressing autonomic states that support threat responses and upregulating autonomic states that support relaxation (Porges, 2022).

# Yoga

*Yoga does not just change the way we see things,  
it transforms the person who sees.*  
– B.K.S Iyengar

Yoga is a physical activity that originated from the eastern tradition and builds upon a theoretical framework of acceptance and presence in the body. Even though yoga has its roots in Indian philosophy and has been a part of spiritual practice for about 4000 years, modern yoga has developed as a secular practice since the 1950s (De Michelis, 2005; Iyengar, 2000). It is important to address that yoga as it is performed today is not part of religious practice (De Michelis, 2005). Practicing yoga has gained popularity during the last decade, and data from national surveys in the US reports that over 31 million Americans have tried some form of yoga practice at least once in their lifetime (Cramer, Ward, et al., 2016). Yoga practices were most common among young females, and most of the responders reported that they used the yoga practice to improve general wellbeing or for general disease prevention, especially pain and stress-related conditions (Cramer, Ward, et al., 2016).

Modern yoga can be practiced in many different forms and styles; however, the core elements consist of body postures (asana) accompanied with conscious breathing (pranayama), awareness (meditation) and relaxation (Iyengar, 2000). In addition, ethical thinking, and a compassionate approach towards oneself and others are also fundamental in the yoga philosophy and often applied during yoga practice (Iyengar, 2000) Yoga is performed at a slow pace with a focus on body awareness and alignment as a tool to foster a deeper understanding of the self and one's own capacity as well as gaining flexibility and strength (Iyengar, 2000). Just like mindfulness, the non-judgmental approach is essential in yoga practice (Iyengar, 2000). In a systematic review comparing different styles of yoga, the effects were similar regardless of what style of yoga was practiced (Cramer, Lauche, et al., 2016).

As an attempt to better understand the potential therapeutic effects of yoga, one way is to look more closely into the specific fundamental elements of yoga practice. In addition to the fundamental role of breathing (previously described in the section above), other important mechanisms of action are ascribed to how yoga is performed. Whereas regular physical exercise increases activity in the sympathetic nervous system, yoga-based practices are performed as a movement of slow to moderate intensity,

focusing on coordination, and balance in combination with controlled breathing to enhance parasympathetic nervous activation (Schmalzl et al., 2015). The coordinated movement as well as the constant tracking of body's positioning in space increases interoceptive awareness (Schmalzl et al., 2015), which is supported by the structural changes of the insular cortex in the brain among yoga practitioners (Villemure et al., 2014). It is further hypothesized that movement performed in this manner increases connectivity within, and dynamic shifting between motor, cognitive and emotional neurocircuits of both cerebellum and the basal ganglia with potential effects for both self-regulation and mind-body integration (Schmalzl et al., 2015). Further top-down processes are addressed by the emotional awareness and the non-judgmental approach as well as the observation of spontaneous emotions and thoughts processes (Schmalzl et al., 2015). The combination of top-down as well as bottom-up processes enhances the possibility to target stress. A growing body of evidence has shown preliminary findings that yoga practice improves cortisol (Estevao, 2022; Garcia-Sesnich et al., 2017; Sullivan et al., 2019) as well as various biologic inflammatory markers such as CRP (Estevao, 2022).

The growing interest in the therapeutic effects of yoga has also been reflected in the scientific field, pointing towards positive effects in various psychological and physiological outcomes. In addition to improvements in stress and depression (Kalra et al., 2022), yoga practice showed a reduction of blood pressure and improved lipid profile in patients with cardiovascular disease (Kalra et al., 2022) as well as improved glucose levels among patients with diabetes (Chen et al., 2022). Yoga interventions showed positive effects on anxiety, depression, and fatigue as well as improved sleep and overall quality of life among patients with breast cancer and were suggested as a potential complementary treatment option (Cramer et al., 2017). Positive findings have also been shown in regard to pain reduction and IBS-related symptoms among adults (Schumann et al., 2016).

Studies on the therapeutic effect among young people have shown that yoga can help children to better cope with stress and anxiety (Bussing et al., 2012; Nanthakumar, 2018; Weaver & Darragh, 2015) as well as depression (James-Palmer et al., 2020). Yoga performed in a school setting showed improvements in both students' and teachers' mental health and wellbeing (Bazzano et al., 2018). Promising results have been shown in studies with yoga for children and adolescents with IBS (Evans et al., 2014; Evans et al., 2018; Kuttner et al., 2006; Mehta et al., 2021). Children and adolescents reported lower levels of gastrointestinal symptoms, functional disability, less use of emotion-focused avoidance and lower anxiety in a small randomized controlled study of one yoga class followed by four weeks of home practice (Kuttner et al., 2006). A randomized controlled study with Iyengar yoga practiced two times a week for six weeks showed



improved physical functioning among adolescents aged 14-17 years (Evans et al., 2014). Almost unanimously, the adolescents in the same sample found that yoga was a beneficial therapy (Evans et al., 2018). Mehta et al studied the effects of a meditation and yoga-focused intervention performed at a pediatric clinic for children and adolescents and found significant improvements in pain relief and improvements. The intervention was concluded to be a cost- effective alternative to treatment as usual (Mehta et al., 2021).

## Mindfulness

*The little things? The little moments? They aren't little.  
– John Kabat-Zinn*

Mindfulness originates from meditation practice (Kabat-Zinn, 2003) and is a practice that fosters self-awareness around thoughts and emotions. By practicing presence and observing thoughts with a non-judgmental and curious attitude, one can be familiar with the internal world and one's own inner mental dialogue. Thereby, compassion towards oneself and others as well as non-reactivity towards emotions can be enhanced (Bishop et al., 2004). Mindful awareness can be defined as the psychological capacity to stay present in the moment, observing thoughts and emotions without acting upon them, most often practiced sitting or lying down as well as engaging in simple physical movement.

By continuously bringing the mind back to the present moment enhances focus and controlling the thought from drifting away into patterns of rumination and worry. By targeting the top-down processes such as worry, the bottom-up processes such as stress and anxiety could be lessened (Zelazo & Lyons, 2012).

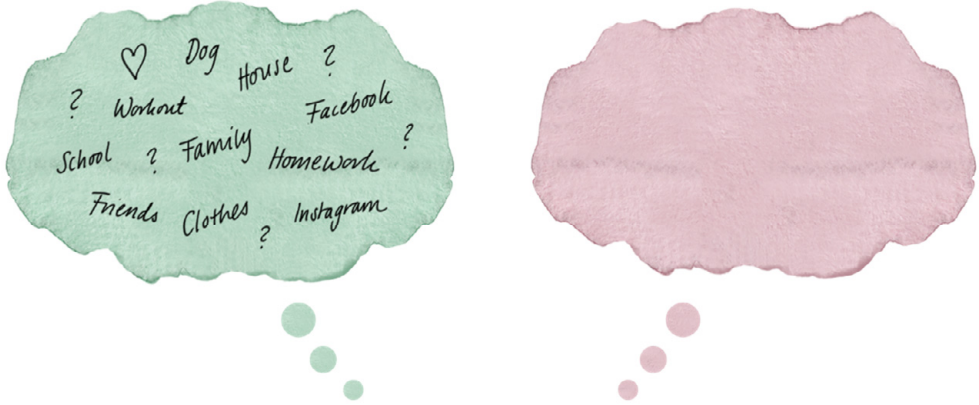
Mindfulness interventions have shown multiple positive health effects among adults (Galante et al., 2021), and have been shown to be equally effective as group cognitive behavioral therapy to treat depression (Sundquist et al., 2015).

Mindfulness practice has also gained popularity worldwide among adolescents and children to foster stress-coping skills ((Dunning et al., 2019; Goldberg et al., 2021), increase emotional wellbeing and resilience (Volanen et al., 2020; Zenner et al., 2014), increase cognitive performance such as attention (Zenner et al., 2014) as well as decrease mental health problems (Dunning et al., 2019; Kannan Kallapiran et al., 2015;

Kuyken et al., 2013; Raes et al., 2014). However, findings from an updated large meta-analyses, which included 66 RCTs with over 20,000 young people, showed significant improvements in attention, executive functioning, social and negative behavior as well as decreased anxiety and stress only in studies with passive control groups. In studies comparing mindfulness with active control groups, mindfulness practice was shown to be superior in terms of improvements in managing anxiety and stress. Mindfulness showed a positive outcome in depression only in selective interventions. Significant improvements were generally small (Dunning et al., 2022).

Even though implementation in the school setting has been shown to be feasible and has been tested in many research projects (Zenner et al., 2014), recently published data points towards opposing results. The MYRIAD study investigated the effects of a mindfulness intervention including 10 sessions, 30-50 minutes in duration delivered during one term, and included 8376 students aged 11-13 from 43 different schools. The mindfulness sessions were delivered by the schoolteachers after being educated with instructor led training. Findings showed no positive outcomes in any domains and even pointed towards worsening of symptoms of hyperactivity and panic disorder post-intervention and lower levels of mindfulness and higher teacher-reported emotional symptoms after one year (Kuyken, Ball, Crane, Ganguli, Jones, Montero-Marín, Nuthall, Raja, Taylor, Tudor, Viner, Allwood, Aukland, Dunning, Casey, Dalrymple, De Wilde, Farley, Harper, Hinze, et al., 2022; Kuyken et al., 2022). The study even suggested iatrogenic effects for individuals with existing or emerging mental health problems (Montero-Marín et al., 2022).

The heterogeneity among published mindfulness studies is, however, large (Felver et al., 2016), and evidence is still lacking regarding the use of mindfulness in school settings. More studies are needed to find effective and easier applicable, cost-beneficial interventions that work and are beneficial and preventive for the students, which easily could be integrated into the school schedule without interfering with normal schoolwork. It is also needed to answer the questions of how, when and for whom mindfulness interventions in schools are most beneficial.



## Mind Full or Mindful?

Figure 4: A figure illustrating the definition of mindfulness

# Aim

The overall aim of this work was to investigate the effects of three different non-pharmacological interventions on mental health and somatic symptoms for school children and adolescents.

Specific aims:

- The primary aim was to evaluate the effects of an 8-month dance intervention on daytime tiredness. The secondary aim was to evaluate the effects on alertness, sleep duration, self-reported items of sleep quality and school satisfaction (Paper I).
- To investigate the effects on diurnal cortisol secretion during and after an 8-month intervention of dance and yoga among girls aged 9-13 years old with FAPDs (i.e., functional abdominal pain and irritable bowel syndrome) (Paper II).
- To investigate the effects of a 10-week school-based mindfulness intervention on symptoms of depression and anxiety among 9–16-year-old school students. Subgroup analyses for age, sex, and levels of symptoms of depression and anxiety at baseline were performed to evaluate whether the effect of mindfulness was modified by certain characteristics. One additional subgroup analysis examined the potential difference in outcome between teacher-led mindfulness practice and mindfulness given by using audio files (Paper III).
- To evaluate the 1-year effect after a 10-week school-based mindfulness intervention on symptoms of depression and anxiety among 9-16-year-old school students as a primary outcome. Sub-group analyses for age, gender, mode of delivery as well as levels of depression and anxiety symptoms at baseline were performed as secondary outcomes (Paper IV).

# Methods

## Paper I: The dance project

### **Design**

The Dance Project was conducted between 2008-2011 and performed as a randomized controlled trial of a dance intervention for adolescent girls with stress-related problems (Duberg, 2016). The intervention was given twice weekly for eight months from October to May. Data were collected via questionnaires administered at baseline and at 8-, 12- and 20-month follow-ups.

### **Participants and setting**

The study took place in Örebro, a medium size city in Sweden with approximately 130,000 residents. The study included adolescent girls aged 13-18 (mean = 16) years old who met the inclusion criteria, which were frequent visits to the school nurse for internalizing problems and/or mental health problems such as the following: headache, stomach ache, aching back or shoulders, tiredness, or persistent feelings of sadness, anxiety or stress. To be included in the study, the girls had to respond “sometimes”, “often” or “always” in items about stress-related somatic or emotional problems or “bad” or “very bad” to an item about self-rated health in the baseline questionnaire. Exclusion criteria were intellectual disability, difficulties with the Swedish language, severe hearing impairment or advice against participation by Child and Adolescent Psychiatric Care.

A total of 112 girls were included, of which 59 participants were randomized to the intervention group and 53 participants were randomized to the control group. The participants in the control group were encouraged to live their life as usual. They received a free cinema ticket every time they completed one of the questionnaires, and they were offered the same dance intervention as the intervention group after the study was completed.

## **Procedure**

The recruitment of eligible participants was performed in collaboration with the school nurses and the school health service. The participants who agreed to participate signed a written consent form after being orally informed about the study. Written consent was obtained from guardians to all girls <15 years of age. The randomization was performed by an external statistician using a computerized randomization list. Randomization was performed either to the intervention or the control group.

Data collection was performed at baseline, as well as at 8, 12 and 20 months and took place at the university hospital, where at least one member of the project team was present to provide help if needed.

## **Intervention**

The dance intervention was performed at a centrally located gym, after school hours twice a week. Three instructors (one instructor/class) guided the classes. The dance instructors were consciously chosen, and all had previous experience teaching dance to adolescents as well as education in either health care or pedagogy. A non-judgmental and supporting approach was the key focus during the whole intervention, and the instructors had an important role to encourage these aspects. There were no elements of competition or performance, instead, the girls were encouraged to focus on enjoyment, acceptance, and social inclusion. The girls' mental or emotional problems were never brought up during the classes. The dance choreographies and the teaching style were agreed upon by all instructors to gain coherence throughout the intervention. In total, 48 classes were held over 24 weeks. No classes were held during holidays from school. Each class lasted for 75 minutes and consisted of 15 min warm-up, 40 min choreographed dance practice, 15 minutes of relaxation and 5 minutes of reflection at the end, as described in Table 1. The style of dance varied during the year and included different choreographies to popular music in the street dance, show/jazz dance, as well as contemporary dance genre. About eight different choreographies were done during the intervention period, which all included sections where the girls created their own dance moves and moved spontaneously. Different emotional themes were highlighted in the choreographies to offer a variety of expressions, i.e. a high-intensity upbeat choreography with a focus on energy and attitude followed by a graceful dance choreography with slower movements focused on introspection.

Table 1. Description of the dance intervention

Minutes	Section	Description
15	Warm-up	<p>Warm up with expansive movements activating large muscle groups. This section was often inspired by African dance to music with prominent drum beats, because of its captivating rhythm and accessible movements.</p> <p>Short improvisation session performed individually. Non-structured movement to enhance body awareness, embodied expression and interpersonal interactions.</p> <p>Short preparation practice, i. e. strength, stretch or joint articulation to prepare for the planned choreography and prevent muscle strains.</p>
40	Dance practice	<p>Choreography to popular music. Structured dance together as a group under the guidance of an instructor, mixed with short sequences of individual improvisation. Focus on enjoyment and socialization rather than performance.</p> <p>Improvisation and exploration of movement in pairs or in small groups, to complement the otherwise structured choreography. This part aimed to strengthen togetherness, stimulate embodied creativity and to encourage the girls to invent their own dance routines.</p>
15	Relaxation	<p>Light massage in pairs, on shoulders or back (5 min) to reduce stress, increase the feeling of community and prepare for the relaxation.</p> <p>Relaxation (10 min) to relax, find peace and calm down after dance practice and to learn relaxation technique.</p>
5	Reflection	<p>Short voluntary sharing, highlighting a positive or powerful experience during this particular dance class, to facilitate prolonged positive feelings.</p>

## Data collection

Data regarding daytime tiredness, sleep, alertness, and school satisfaction were collected through questionnaires administered at baseline, as well as 8, 12 and 20 months. Questions were the same as used in “Life and Health Young People (Lindén-Boström & Persson, 2009), which is a survey widely used for young individuals in Sweden. All questions are presented in Figure 5 as they appeared in the questionnaire. Answering options for all questions except the question covering sleep duration were presented as 1-5 and all questions except sleep duration and school satisfaction were designed to describe the frequency of symptoms during the last three months. The 8-month follow-up thereby represented the time during the second half of the intervention, and the 12- and 20- month follow-ups represented the time periods after the intervention.

How often during the last 3 months have you experienced;	Never	Infrequently	Sometimes	Frequently	Always
Tiredness during the day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Alertness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
One of the following issues:					
- problems falling asleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- worried sleep	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- waking up during the night	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
- nightmares	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Very good	Good	Okay	Bad	Very bad
How do you like being in school	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How many hours do you normally sleep each night during:

The weekdays \_\_\_\_\_

The weekend \_\_\_\_\_

Figure 5. A figure showing the questions as they were used in the questionnaire.

## Ethical permission

The regional Ethical Review Board in Uppsala, Sweden, approved the study (DNR, 2008/134).

## Statistical analyses

The effect of the intervention was evaluated by calculating the change from baseline to each follow-up, measured as increased, decreased or unchanged. A sign test was used for comparison within groups, and a Mantel-Haenszel chi-square test was used for comparison between groups in measures regarding a change in daytime tiredness and alertness. Regarding sleep hours, the Wilcoxon signed-rank test was used for comparisons within groups, and the Mann-Whitney  $U$  test was used for comparisons between groups. The difference in proportions between the groups was calculated along with 95% confidence limits. Fisher's exact test was used for the comparison of proportions between two groups in regard to baseline differences. A Cochran Mantel-Haenszel test was used when adjusting for baseline differences. All significant tests were two-sided and were determined based on a 0.05 significance level. Analyses were performed using the IBM Statistical Package for Social Sciences (IBM SPSS) version 21 (IBM Corp, Armonk, NY) and SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, U.S.).



## Paper II: Just In TIME

### **Design**

The study was performed as a prospective randomized controlled study with one intervention group and one control group. The current study described in this thesis was a part of a larger study called “Just In TIME” (Try, Identify, Move, Enjoy) that investigated the effects of a dance and yoga intervention on girls 9-13 years of age with FAPDs. The trial has been described before in a study protocol (Philipson et al., 2020) and also in regards to its effects on the main outcome - abdominal pain (Högström et al., 2021). Clinical trial registration number: NCT02920268.

### **Participants and setting**

The participants were girls aged 9-13 with FAPDs or IBS. As the Rome III criteria were still in use at the time when the study began, these were used as inclusion criteria for consistency throughout the study (Rasquin et al., 2006). The intervention started in Örebro county. However due to difficulties in finding and including enough study participants, the study was extended to also include the neighboring county of Västerås. Recruitment of participants was made from the local registry of diagnoses of the Departments of Pediatrics in Örebro and Västerås, from primary health care centers in the regions of Örebro and Västerås as well as through advertisements in local media in the Örebro and Västerås counties. After written consent was received from the legal guardians, the diagnosis according to the inclusion criteria was verified through the medical records and/or by a medical examination by a pediatrician. Participants were screened for underlying diseases and were excluded if they had celiac disease or inflammatory bowel disease as a comorbidity. Further exclusion criteria were difficulties to follow instructions (language difficulties or hearing impairment), severe psychiatric symptoms demanding other treatment or current treatment with CBT. Pain had to be persistent over the last three months prior to baseline to be included in the study.

### **Procedure**

Girls and their legal guardians who consented to participate in the study and were eligible for the study in accordance with the inclusion criteria completed the baseline measurement. Baseline data was collected via questionnaires administered in an auditorium at both sites after school hours, where also some more detailed study information was given. Members of the research team were present during the time of

data collection to provide assistance and answer questions if needed. A medical doctor was also present at the baseline measurements to measure weight and height. The participants filled in a pain diary at home for a one-week period at baseline. To be included in the study, abdominal pain had to be reported with a severity of at least four or higher according to the Faces Pain Scale-Revised (FPS-R) (total range 1-20) (Hicks et al., 2001) at least once during the week of fulfillment. The girls were also screened for depression at baseline using the Children's Depression Screener (Child-S) (Fruhe et al., 2012). Girls that scored 13 or higher were offered an appointment with a psychologist to assess whether further support was needed and whether participation in the study was appropriate or not.

Randomization was performed by an external statistician and was based on site, age, and pain intensity at baseline. Information about group assignments was then sent out by mail to the legal guardians.

## **Intervention**

Eligible instructors were chosen to teach the intervention. All instructors had basic education in healthcare or pedagogy and previous experience in teaching dance or yoga. They also received a two-day course given by one of the members of the research team. The course included practical information about the standardized dance and yoga method, including dance choreography, yoga sequences, and essential elements of the intervention such as teaching in a supportive and non-judgmental manner. To enhance coherence throughout the study, the instructors received a written manual with teachings, themes, and music. The instructors were also followed up with booster sessions, including additional choreographies and repetition of essential elements of the intervention to ensure fidelity to the method. In total, three instructors at each site were educated, and one or two instructors were present at each session. The instructors alternated in leading the classes during the intervention period.

The dance and yoga intervention was performed twice weekly for a period of eight months, from September to May with a short break over Christmas. The classes were held at a school in the center of the city after school hours. Each session was 60 minutes long and included 30 minutes of dance, 25 minutes of yoga and relaxation and 5 minutes of reflective sharing at the end. Each group consisted of 7-14 participants.

The dance section included a warm-up session with playful games as well as up-tempo music and a captivating rhythm to engage large muscle groups. After the warmup, a short, choreographed section was led by the instructor. Each choreography was practiced for a couple of weeks and covered different styles of dance and different types

of music. The focus of the dance sessions was on playfulness, enjoyment, and socialization rather than performance. The yoga sessions consisted of easy and playful movements performed both individually as well as in pairs and groups. Creative storytelling was used during the yoga sessions, with a focus on breathing, attention, and body awareness. Yoga postures included balancing postures and postures with a focus on moving, stretching and massage of the abdomen. Both centers followed the same routine.

The control group was requested to live as usual, and health care was as always available for everyone when needed during the study period. All participants received a movie-ticket after each follow-up to show appreciation for their participation in the study.

Table 2. Description of the dance and yoga intervention (copy from study protocol) (Philipson et al., 2020).

Minutes	Section	Description
10	Warm-up	The warmup section aimed to get the participating girls to be active and take part in social cohesion. It included up-tempo music with prominent drum beats and a captivating rhythm. Expansive easy accessible movements activated large muscle groups.
20	Dance choreography	<p>The dance choreography section included mostly structured dance as a group under the guidance of an instructor but also included improvisation and playful exploration of movement. The focus was on enjoyment and socialization rather than performance. The intention was to offer an opportunity to experience one's own body in a positive way with popular music in an undemanding and supportive atmosphere as well as to increase heart rate with moderate-to-vigorous physical activity,</p> <p>Month 1-2: Focus on experiencing the joy of movement, feeling safe, and getting to know each other. Dance style: show jazz.</p> <p>Month 3: Focus on expansive movements, "claiming space," determination, and integrity. Dance style: show jazz and street dance.</p> <p>Month 4: Focus on body awareness, slow movements, and grace. Dance style: jazz and contemporary dance.</p> <p>Month 5-6: Focus on increasing energy and working together as a group in the choreography. Dance style: show jazz.</p> <p>Month 7-8: Focus on enjoyment and meeting variations in the dance movements (high-low, firm-soft, and expansive-small variations). Dance style: show jazz and floor work.</p>
20	Yoga	<p>The yoga section focused on playful movements, such as creative yoga storytelling combined with asanas (body poses), a focus on breathing and attention. Asanas were performed individually or in pairs and, when appropriate, together as a group.</p> <p>Month 1-2: balasana (child's pose), marjaryasana (cat pose) and bitilasana (cow pose), parsva sukhhasana (seated side bend pose), uttanasana (standing forward bend), upavistha bitilasana marjaryasana (seated cat-cow pose), jathara parivrtti (revolved abdomen twist pose)</p> <p>Month 3: parivritta sukhhasana (sitting twist pose), parsvaparyasana in tadasana (standing side bend), uttanasana (standing forward bend), sufi grind (seated torso circles), paranamuktasana (knees to chest), jathara parivrtti (revolved abdomen twist pose)</p> <p>Month 4: virabhadrasana II (warrior II), ardha chandrasana (half-moon pose), ardha setubandhasana (half-bridge pose), adho mukha sukhhasana (easy pose forward bend), upavistha bitilasana marjaryasana (seated cat-cow pose), jathara parivrtti (revolved abdomen twist pose)</p> <p>Month 5-6: vrksasana (tree pose), utthita trikonasana (extended triangle pose), upavista konasana (seated wide angle posture), adhomukha svanasana (downward-facing dog posture), balasana (child's pose), paranamuktasana (knees to chest), sufi grind (seated torso circles), jathara parivrtti (revolved abdomen twist pose)</p> <p>Month 7-8: extended focus on creative yoga storytelling in group, phalakasana (plank pose), adhomukha svanasana (downward-facing dog posture), bhujangasana (cobra pose), ardha setubandhasana (half-bridge pose), jathara parivrtti (revolved abdomen twist pose)</p>
5	Relaxation	Pranayama (slow breathing and attention to the breath) savasana (corpse pose), guided relaxation to increase calmness and lying down with blankets. During the relaxation, a brief massage on the shoulders was offered by the instructors (voluntary).
5	Reflection	Finally, a short voluntary sharing session was held while seated in a circle, highlighting a positive experience during this particular class.

## **Data collection**

Saliva cortisol samples from both the intervention group and control group were handed equally. Samples were collected at home at baseline as well as at four months and at eight months using a Salimetrics polymer swab two times during a school day. The girls were instructed to take the morning sample as soon as possible after waking up around 07.00 am +/- 1 h, preferably when still in bed. The evening sample was taken at 08.00 pm +/- 1 h, and at least one hour after food intake, excessive exercise or teeth brushing to avoid contamination. The samples were either picked-up in the girls' homes by members of the research team or sent to the lab in prepaid envelopes. The samples were centrifuged upon arrival at the laboratory in Örebro, and immediately stored at -20 degrees Celsius. The samples were then sent to Linköping University for analysis. The samples were transported stored in dry ice to secure an unbroken freezing chain. The samples were analyzed using a commercial enzyme immunoassay method (Salivary Cortisol Enzyme Immunoassay Kit; Salimetrics LLC). A Tecan robot method was used, modified to suit a 25- $\mu$ L saliva volume. The intra assay coefficient of variation (CV) was 5%, and the total CV was 7.7 and 7.5% for low and high values, respectively

Abdominal pain was measured with Faces Pain Scale- R three times a day during a period of one week. Clinical responses was counted if the mean value in the diary showed a mean decrease of two or more during the one-week measure. Stress levels were assessed by answering the question "How often have you experienced stress over the last week?" on a 5-level scale (0 = always, 1 = often, 2 = sometimes, 3 = rarely, and 4 = never) in the questionnaire administered at baseline and at each follow up.

## **Ethical permission**

The regional Ethics Committee of Uppsala, Sweden, approved the study (dnr: 2016/082/2).

## **Statistical analyses**

A power calculation of the sample size was performed for the outcome of abdominal pain. All data were analyzed using the SPSS (Statistical Package for the Social Science, version 24, IBM Corp., Armonk, NY, United States). A p-value of <0.05 was considered statistically significant. Calculations were performed as an intention to treat as well as per protocol where a cut off was set as 50% attendance to the study. The outcome of the per-protocol analysis resulted in minor differences compared to the intention-to-treat values, therefore, only intention-to-treat analyses are further presented. All parameters were tested for normal distribution. An independent t-test

was used on continuous data to evaluate differences between groups, and a chi-square test was used on categorical data on all baseline measures. Cortisol levels are presented as median with interquartile ranges (IQR). Cortisol data were analyzed with non-parametric test since the distribution was skewed. Mann-Whitney U test was used for comparison between groups and the Wilcoxon signed-rank test was used for comparison between different time points within groups. To adjust for variances in baseline values, each participant's evening value was divided by the morning value to get an evening/morning quotient. This calculation gives a quota between 0-1; a method that has been used before (Ivars et al., 2017). A smaller quota indicates a more pronounced diurnal rhythm. Saliva cortisol was also analyzed in the total population in regards to clinical outcome, meaning a decrease of two or more on the FPS-R assessment. Median, as well as IQR of the evening/morning quota, was calculated in the group with decreased abdominal pain and with no decrease of abdominal pain. Stress levels were compared between groups as percentages as well as median (IQR). Differences between groups in regard to abdominal pain and stress were measured with Mann-Whitney U test.

## Paper III and IV: The mindfulness project

### **Design**

The mindfulness project was a controlled trial performed in the school setting. The intervention took place from 2016-2019, and of the 2536 eligible participants, a total of 1399 participants consented to the intervention and were thus included. Mindfulness was performed in the classrooms daily for 10 weeks. Collection of baseline data was performed before the intervention started and following-up measures were collected immediately after the intervention (Paper III) and after one year (Paper IV).

### **Participants and setting**

The mindfulness project was performed in Skåne, Sweden's southernmost county, which has approximately 1.4 million inhabitants. School classes in primary and middle schools were recruited via contact with the school principals. A total of 65 schools were invited via letters, and an additional few principals contacted the research team themselves. A total of 12 schools with students aged six to 16 were included in the study. Schools from different parts of the county, representing both low and high socioeconomic areas, were included to enhance the representativeness of the study

sample. School classes were then assigned to either the mindfulness intervention or no intervention (control group). The principals chose which classes to allocate the respective group, and they were asked to choose the class assignment as equally as possible within their schools. The whole school class was included in the intervention, and no exclusion criteria were applied.

## **Procedure**

The school principals and the schoolteachers were first informed about the study at workplace meetings. After acceptance from principals and teachers, parents were invited to informational meetings at the schools. A written consent form was filled in and collected from the guardians and was a prerequisite for study participation. Parents that could not attend the informational meetings had written information about the study sent to their homes. The parents were instructed to carefully inform their children about the study, that participation was optional and that they were allowed to quit participation at any time if they wished to do so.

## **Intervention**

The intervention started with a mindfulness instructor course for the class teachers that were allocated to the mindfulness intervention. The course was given to all teachers at no cost, and constituted of four to six sessions, with a mixture of lectures, meditative practice, and personal mindfulness training for eight weeks. The mindfulness instructor course was held by one of the researchers in the team who is a family physician and mindfulness instructor trained in mindfulness-based cognitive therapy (MBCT) at the University of Oxford Mindfulness Center, and in the mindfulness two-step certification program at the Swedish Mindfulness Center (MFC). The instructor course was based on contemplative mindfulness traditions (Goldstein & Kornfield, 2001), mindfulness-based stress reduction (MBSR) (Kabat-Zinn, 1990), and MBCT (Segal et al., 2002). The teachers were trained in personal mindfulness practice, as well as guiding individuals and groups to develop a greater awareness and to better cope with stress and other difficulties. The teachers were informed to keep up with mindfulness training for at least 20 minutes per day. In addition, they received an audio file with recorded instructions to better keep up with the practice at home.

To enhance coherence throughout the intervention, all teachers received a manual with descriptions of the 10-week intervention for different school grades (3-6 and 7-9) as well as age-appropriate audio files that could be used in the classrooms if the teachers decided to.

The mindfulness school intervention consisted of daily mindfulness practice in the school classrooms at a time when the teacher found it appropriate. The intervention lasted for 10 weeks, and all students in the classroom attended. The sessions were customized for different age groups, with shorter sessions for the younger students (5-9 min for grades 3-6 and 7-11 minutes for grades 7-9). The mindfulness sessions covered different themes each week, as described in Table 3, and included themes such as compassion and gratitude as well as breathing exercises, and body scan. All sessions started with a short 90 second introduction. The teachers could add a short reflection in the whole group after the session if they wanted to. The teachers filled in a weekly schedule about the number of mindfulness sessions each week including length, theme and mode of delivery (teacher-led or led by audio recording).

Children in the control group continued with their schoolwork as usual.

Table 3. Describes the mindfulness intervention and how it was adapted for younger and older students.

Week	Exercises school grades 3-6	Time (min)	Exercises school grades 7-9	Time (min)
1	Breathing and sound, where the body can feel its breath	5	Breathing anchor, awareness, presence and concentration	8
2	Body scan	7	Body scan	10
3	Love and kindness towards oneself and others	8	Concentration via mindful breathing	8
4	Gratitude	7	Reduce anxiety	7
5	Your hands, practice concentration and body scanning	7	Sound, create presence and concentration	10
6	Sadness, anger, worry, sorrow	6	Attentive thoughts to create a sense of calm	11
7	Movement exercise, what happens in the body during movement	9	Standing attention, the body and concentration	8
8	Breathing anchor, awareness, presence and concentration	5	Breathing anchor, awareness, presence and concentration	10
9	Before test, awareness and concentration	5	Good as you are	10
10	Optional exercises from weeks 1-9	5-9	Meeting your challenges	10

## Data collection

All children, regardless of group assignment filled in a comprehensive and age-appropriate questionnaire about themselves regarding the following: family situation, school situation, origin, leisure time, health, common diseases, stress and health behaviors a couple of days prior to the start of the intervention as well as after the end of the intervention (Paper III). The same questionnaire was administered after one year (Paper IV). These questions about themselves were adapted from the public health survey of children and adolescents in Skåne (Fridh et al., 2018; Lindström & Rosvall, 2018).



Included in the questionnaires were two of the five Beck Youth Inventories, measuring symptoms of depression and anxiety. Beck Anxiety Inventory (BAI) includes items that reflect worrying, fear and other psychological symptoms of anxiety. Beck Depression Inventory covers items regarding the children's feelings of sadness as well as negative thoughts about themselves, their lives and their futures and other psychological indicators of depression (Beck, 2001; Beck et al., 2001). Each inventory consists of 20 statements, where the respondent rates their experience of agreement on a 4-point scale from: 0 = never, 1 = sometimes, 2 = often, 3 = always). Each inventory is scored by adding the 20 ratings. The full inventory takes around 10 minutes to complete (Beck, 2001; Beck et al., 2001). The BDI has shown satisfactory internal consistency and test-retest reliability among adolescents (Basker et al., 2007; Thastum et al., 2009), and has been suggested as a useful screening instrument in school settings (Thastum et al., 2009). The questionnaires were tested for readability by children in respective age categories.

All data were collected in the school classroom during a normal school day, and members of the research team were present in case any questions arose during the time of filling it in. Students with language difficulties or dyslexia were provided with extra help from the research team staff or teachers if necessary.

The questionnaires were sent home to all students who for any reason (moved, changed school, sick leave) were not present at the one-year follow-up. At least one reminder was sent out if the questionnaire was not returned in the first round. Both paper and electronic versions were used. Questionnaires that were filled in on paper were transferred to a database by the research group using the research electronic data capture (RedCap) program. Electronically filled in questionnaires were automatically transferred to the same database.

### **Ethical permission**

The study was approved by the Regional Ethics Review Board in Lund (registration number 2016/299). The study was registered at ClinicalTrials.gov (identifier: NCT03327714).

### **Statistical analyses**

All analyses were performed on the two Beck subscales with each subscale including 20 items. If more than two items were missing, the subscale was counted as missing. For those who had missing values on one or two items, the missing values were replaced with the mean number of the non-missing items. The Beck score was transformed to

percentiles using a normative population including approximately 2400 Swedish school Children aged 9-19 from five different Swedish cities (Beck, 2001).

Subject characteristics and primary outcomes were described with mean values and standard deviations, medians, interquartile ranges, frequencies, and percentages. Differences were analyzed between the mindfulness group and the control group as well as changes within groups. To account for the nested structure of repeated measurements, the primary outcomes were analyzed using linear mixed models, where we assumed equally correlated observations within individuals and all available data were used. Mixed models were also used to test the nested structure of students within classes and schools. A stratified analysis by gender was performed. The difference in outcome dependent on the mode of delivery was also examined. Students who received more than half of the sessions teacher-led were classified as the teacher led group and students who received more than half of the sessions given via audio files were classified as the audio file group.

A power calculation was performed and resulted in a cluster size of 625 (25 classes) per group, i.e. at least 1250 students (50 classes).

## Paper IV

The statistical analyses were performed in a similar way to the analyses after 10 weeks. Mean changes compared to baseline for both 10 weeks and one year were analyzed, and the analyses included all students that remained in the study after one year. Since the students that were lost to follow up differed in baseline characteristics compared to the students that completed the study, two different sensitivity analyses were performed to handle the missing data and examine if the conclusions remained the same. We then used last observation carried forward (LOCF) and conducted an analysis where we matched participants on age and Beck score.

# Results

## Paper I

### **Baseline characteristics**

A total of 112 girls aged 13-18 (mean age 16 years) were included in the study. None of the participants reported any regular use of sleep medication. The mean sleep duration was similar in both groups during school weeks and weekdays. The background data were well-balanced in most of the variables. Unfortunately, the study sample showed differences between the intervention group and the control group regarding levels of alertness and school satisfaction at baseline. Unadjusted and adjusted p-values are presented and discussed below. All baseline characteristics are described in Table 4.

Table 4. Baseline characteristics

Demographic	Intervention group n = 59 (%)	Control group n = 53 (%)	p-value
Age 13-14 years <sup>a</sup>	11 (19%)	13 (25%)	0.70
Age 15-16 years	27 (46%)	23 (43%)	0.29
Age 17-18 years	21 (35%)	17 (32%)	0.27
Born in Sweden	55 (93%)	49 (93%)	0.88
Mother on sick leave	6 (10%)	6 (11%)	0.85
Father on sick leave	3 (5%)	3 (6%)	0.88
Participated in dance before start of study	33 (56%)	36 (68%)	0.20
Physically active once/week or more before start of study	43 (73%)	33 (62%)	0.23
Rate their health as poor or very poor	8 (14%)	3 (6%)	0.16
Experienced tiredness <sup>b</sup>			
-Never	0 (0%)	0 (0%)	
-Rarely	2 (3%)	7 (13%)	
-Sometimes	12 (21%)	10 (19%)	
-Often	27 (47%)	24 (45%)	
-Always	17 (29%)	12 (23%)	0.15
Experienced alertness <sup>c</sup>			
-Never	4 (7%)	2 (3.8%)	
-Rarely	20 (34%)	13 (2%)	
-Sometimes	18 (31%)	13 (25%)	
-Often	16 (27%)	21 (40%)	
-Always	1 (2%)	4 (7.5%)	0.004
Sleep (hours) duration Weekdays, mean, (SD) <sup>i</sup>	6.95 (1.33)	7.24 (1.41)	0.53
Min:max	4:10	5:12	
Sleep (hours) duration Weekends, mean (SD) <sup>i</sup>	8.90 (1.71)	9.05 (2.00)	0.68
Min:max	4:12	4:13	

<sup>a</sup> Mean for both the intervention group and the control group = 16 years. <sup>b</sup> Data for tiredness were missing for 1 participant in the intervention group and for 0 participants in the control group. <sup>c</sup> There were no missing participants regarding alertness.

## Daytime tiredness and alertness

Daytime tiredness and alertness improved significantly among participants within the dance intervention group at all follow-ups compared to levels at baseline. A significantly larger amount of the girls in the dance intervention group compared to girls in the control group showed decreased tiredness at all follow-ups; 42.9% vs 28% at 8 months ( $p=0.037$ ); 58.3% vs 33.3% at 12 months ( $p=0.005$ ); and 47.9% vs 30.2% at 20 months ( $p=0.031$ ).

More girls in the dance intervention compared to the girls in the control group reported increased alertness at 8 months, however not significant; 48% vs 29% ( $p=0.075$ ). A significantly larger amount of the girls in the dance intervention group showed

increased alertness at 12 and 20 months compared to the girls in the control group; 49% vs 27% at 12 months ( $p=0.039$ ), and 47% vs 21% at 20 months ( $p=0.022$ ). However, after adjustments for baseline differences at baseline, no significant differences remained at none of the follow-ups. All data are shown in Table 5.

Table 5. Change in tiredness, alertness and school satisfaction at the 8, 12 and 20-month follow-ups compared to baseline. P-values are presented for comparisons within groups and between groups.

Variable	Control Group (n=53)		Intervention group (n=59)		p-value	Difference in percentages (95% CI)
	n (%)	p-value	n (%)	p-value		
Tiredness 8 months						
Decrease	14 (28.0%)		21 (42.9%)			
Unchanged	19 (38.0%)		20 (40.8%)			
Increase	17 (34.0%)	0.72	8 (16.3%)	0.024	0.037	-14.9 (-33.5; 3.8)
Tiredness 12 months						
Decrease	15 (33.3%)		28 (58.3%)			
Unchanged	20 (44.4%)		17 (35.4%)			
Increase	10 (22.2%)	0.42	3 (6.3%)	<0.0001	0.005	-25.0 (-44.6; -5.4)
Tiredness 20 months						
Decrease	13 (30.2%)		23 (47.9%)			
Unchanged	19 (44.2%)		20 (41.7%)			
Increase	11 (25.6%)	0.84	5 (10.4%)	0.0009	0.031	-17.7 (-37.4; 2.0)
Alertness 8 months						
Decrease	7 (14.3%)		5 (10.0%)			
Unchanged	28 (57.1%)		21 (42.0%)			
Increase	14 (28.6%)	0.19	24 (48.0%)	0.0005	0.075	-19.4 (-38.2; -0.7)
Alertness 12 months						
Decrease	9 (20.0%)		6 (12.2%)			
Unchanged	24 (53.3%)		19 (38.8%)			
Increase	12 (26.7%)	0.66	24 (49.0%)	0.00014	0.039	-22.3 (-41.4; -3.3)
Alertness 20 months						
Decrease	11 (25.6%)		8 (16.3%)			
Unchanged	23 (53.5%)		18 (36.7%)			
Increase	9 (20.9%)	0.82	23 (46.9%)	0.011	0.022	-26.0 (-44.5; -7.5)

For the secondary outcomes of sleep duration and self-reported sleep measures as well as school satisfaction, please see the published article at the end of this thesis.

# Paper II

## Baseline characteristics

The baseline characteristics were well balanced between the intervention and the control group as presented in Table 6. The mean age at the start of the intervention was 10.4 years (SD=1.4) in the intervention group and 10.7 years (SD = 1.3) years in the control group. There were no differences in morning or evening cortisol levels at the start (Table 7). The median (IQR) morning and evening values for all included participants were 10.5 (7.9–13.9) and 1.1 (0.8–1.5) nmol/L, respectively.

Table 6. Baseline Characteristics

	Intervention n=59	Control n=55
Age at start (year) mean (SD)	10.4 (1.37)	10.7 (1.32)
Diagnose, n (%)		
IBS	25 (42%)	19 (35%)
FAP	34 (58%)	36 (65%)
Height, (m) Mean (SD)	1.47 (0.10)	1.47 (0.09)
Weight class, n %		
Underweight	5/56 (9%)	4/51 (8%)
Normal	36/56 (64%)	40/51 (78%)
Overweight	8/56 (14%)	5/51 (10%)
Obese	7/56 (12.5%)	2/51 (4%)
BMI (kg/m <sup>2</sup> ) Mean (SD)	19.18 (4.03)	18.17 (3.02)
Menarche n (%)		
Yes	5/58 (9%)	6/55 (11%)
No	53/58 (91%)	49/55 (89%)
Child-S,		
Mean (SD)	8.68 (4.265)	7.98 (4.357)
Median (IQR)	9.0 (5.50-11.00)	8.0 (5.00-10.00)
Self-Rated Health		
Mean (SD) Median (IQR)	2.8 (0.56) 3.0 (2.00-3.00)	2.75 (0.726) 3.0 (2.00-3.00)
Reported stress		
-Never	7	9
-Rarely	16	14
-Sometimes	20	21
-Often	11	11
-Always	5	0
Median (IQR)	2 (1-3)	2 (2-3)

## Changes in morning and evening cortisol values

The evening value was significantly lower in the intervention group at the four month follow-up than in the control group, with a median (IQR) of 0.9 (0.6–1.2) nmol/L compared to 1.2 (0.8–2.2) nmol/L ( $p = 0.01$ ). However, the difference was not statistically significant in comparison to the baseline value ( $p=0.055$ ). Both groups had significantly reduced evening values at eight months compared to baseline; 5.7 (2.9–10.2) nmol/L ( $p \leq 0.001$ ) and in the control group; 6.9 (4.6–11.2) nmol/L ( $p = 0.019$ ), no significant difference was observed between the two groups. Cortisol values are presented in Table 7.

Table 7. Saliva cortisol levels at baseline and during the intervention. All saliva cortisol levels are presented in nmol/L. The median and IQR were used since the data distribution was skewed. Saliva cortisol levels between the intervention and control groups were compared with the Mann-Whitney U test, and the Wilcoxon signed-rank test was used for comparisons between different time points within groups

	Intervention	Control	p-value
<b>Morning values</b>			
n=	59	55	
Baseline median, (IQR)	10.9 (8.8-14.2)	10.1 (7.6-13.3)	0.108
n=	48	41	
<b>4 months</b>			
median, (IQR)	11.2 (7.2-16.3)	9.5 (7.3-12.4)	0.055
P value (compared to baseline)	0.72	0.91	
n=	49	46	
<b>8 months</b>			
median, (IQR)	5.7 (2.9-10.2)	6.9 (4.6-11.2)	0.375
P values (compared to baseline)	<0.001	0.019	
<b>Evening values</b>			
n=	58	52	
Baseline median, (IQR)	1.1 (0.9-1.8)	1.1 (0.8-1.5)	0.710
n=	48	41	
<b>4 months</b>			
median, (IQR)	0.9 (0.6-1.2)	1.2 (0.8-2.2)	0.010
P value (compared to baseline)	0.055	0.428	
n=	47	42	
<b>8 months</b>			
median, (IQR)	0.9 (0.6-1.5)	1.0 (0.7-1.4)	0.776
P value (compared to baseline)	0.555	0.179	
<b>Evening/morning quotient</b>			
n=	58	50	
Baseline median, (IQR)	0.111 (0.08-0.15)	0.107 (0.07-0.18)	0.753
n=	47	40	
<b>4 months</b>			
median, (IQR)	0.087 (0.05-0.15)	0.142 (0.09-0.26)	0.004
P- value (compared to baseline)	0.249	0.140	
n=	46	42	
<b>8 months</b>			
median, (IQR)	0.167 (0.08-0.43)	0.143 (0.09-0.22)	0.491
P-value (compared to baseline)	<0.001	0.199	

### **Changes in evening/morning quotient**

The evening/morning quotient was significantly lower in the intervention group compared to the control group at four months; median (IQR) 0.087 (0.05–0.15) nmol/L vs. 0.142 (0.09–0.26) nmol/L ( $p = 0.004$ ). The difference did not remain at eight months. Both groups showed a significantly higher evening/morning quotient at eight months compared to baseline values ( $p < 0.001$ ). Values are presented in Table 7.

### **Saliva cortisol in relation to abdominal pain and reported stress levels**

No significant difference in evening/morning quotient was observed within the intervention group between the individuals who showed decreased abdominal pain compared to the girls who did not show any decrease in abdominal pain. Neither were there any differences between reported stress levels between the groups.

## Paper III

### **Baseline characteristics**

Of the 2536 invited students aged 9-16, a total of 1399 students (55%) agreed to participate in the study. More girls than boys agreed upon participation (60% vs 40%). The students who did not consent to participate were slightly older than the students who consented. All baseline characteristics are presented in Table 8.

In total, drop-out rates were low. Seven students in the intervention group and 14 students in the control group dropped out. The flowchart of included children is presented in Figure 6

During the 10-week intervention time, a mean of 38 sessions per school class were given with a mean length of 10 minutes per session. Most of the teachers chose to deliver the sessions via audio files (81%) instead of teaching the sessions themselves (16%). In 3.5% of the sessions, the teachers chose another kind of mindfulness activity apart from the sessions that were included in the manual. These sessions comprised of listening to music and other kinds of relaxation practices. Characteristics of the mindfulness sessions are presented in Table 9.



Table 8: Characteristics at baseline of all children (school class 3-9) in the mindfulness and control group

	<b>All children (N = 1394)</b>	<b>Mindfulness (N = 902)</b>	<b>Control (N = 492)</b>
Age, mean (SD)	12.3 (2.0)	12.2 (2.0)	12.6 (1.9)
Class 3-5, n (%)	548 (39)	367 (41)	181 (37)
Class 6-9, n (%)	846 (61)	535 (59)	311 (63)
Sex (male/female), %	48/52	48/52	50/50
<b>Country of birth, n (%)</b>			
Sweden	1090 (93)	706 (92)	384 (93)
Other Nordic country	15 (1.3)	11 (1.4)	4 (1.0)
Other European country	30 (2.6)	19 (2.5)	11 (2.7)
Outside Europe	42 (3.6)	29 (3.8)	13 (3.2)
Missing data	16%	15%	16%
<b>Parents' occupation, n (%)</b>			
Work (full-time or part-time)	1064 (79)	682 (79)	382 (79)
Other (e.g. unemployed, student or on sick leave)	280 (21)	186 (21)	94 (21)
Missing data	4%	4%	3%
<b>Live with, n (%)</b>			
Both parents	934 (79)	621 (81)	313 (76)
Equal time between parents	114 (9.7)	67 (8.7)	47 (11)
Mostly with one parent	81 (6.9)	51 (6.5)	30 (7.3)
One parent	47 (4.0)	28 (3.7)	19 (4.6)
Not with any parent	2 (0.2)	1 (0.1)	1 (0.2)
Missing data	15%	15%	17%
<b>Beck score, percentiles*</b>			
<i>Depression</i>			
Median (IQR)	52 (54)	52 (54)	52 (54)
Mean (SD)	53 (30)	53 (30)	52 (30)
Missing data	6%	4%	9%
<i>Anxiety</i>			
Median (IQR)	64 (54)	64 (55)	64 (51)
Mean (SD)	60 (30)	60 (30)	59 (30)
Missing data	6%	4%	9%
<b>Beck score, categories</b>			
<i>Depression, n (%)</i>			
Average (<= 74)	906 (69)	587 (68)	319 (71)
Slightly increased (75-89)	206 (16)	146 (17)	60 (13)
Much increased (>= 90)	201 (15)	132 (15)	69 (15)
<i>Anxiety, n (%)</i>			
Average (<= 74)	798 (61)	527 (61)	271 (60)
Slightly increased (75-89)	229 (17)	137 (16)	92 (21)
Much increased (>= 90)	288 (22)	203 (23)	85 (19)

\*Beck score was transformed to percentiles ranging from 1 to 99 using a normative population

Table 9: Mindfulness intervention (assessed by weekly schedules filled in by the mindfulness leader)

Total number of mindfulness school classes	61
Total number of control school classes	45
Total number of mindfulness classes with weekly schedules	55 (90%)
<i>Number of mindfulness sessions per school class during 10-week follow up</i>	
Min-max	0-49
Mean (SD)	38 (9.2)
Median (IQR)	39 (9)
<i>Total amount of mindfulness per school class during 10-week follow up, hours</i>	
Min-max	2-11
Mean (SD)	5.9 (1.7)
Median (IQR)	6.1 (2.2)
<i>Amount of mindfulness per session and school class, minutes</i>	
Min-max	4-30
Mean (SD)	9.7 (2.4)
Median (IQR)	9.9 (1.5)
<i>Type of intervention, percentage of sessions</i>	
CD/audio file	81%
Led by teacher	16%
Other	3.5%

## Changes in depression and anxiety symptoms

No significant change in either symptoms of depression or anxiety was seen in the mindfulness intervention group or in the control group after the end of the intervention. Symptoms of anxiety decreased significantly within both groups; mean change in the intervention group was -2.2 ( $p=0.004$ ) and in the control group -2.7 ( $p=0.02$ ), with no significant difference in change of symptoms between the groups, 0.5 ( $p=0.65$ ). There was no significant change in symptoms of depression in either the mindfulness intervention group or the control group after the intervention; 0.6 (0.44) in the intervention group and -0.3 ( $p=0.79$ ) in the control group, the difference in change between the groups was 0.8 ( $p=0.53$ ).

The primary outcomes are presented in Table 10.

Accounting for correlation between individuals within the same classes and schools changed the estimates negligibly, indicating that clustering of observations was seen primarily within individuals rather than within schools or classes.

Table 10: Primary outcomes after 10-week follow-up

	Beck score <sup>a</sup> , depression			Beck score, anxiety		
	Mindfulness (N = 902)	Control (N = 492)	Difference between groups <sup>b</sup>	Mindfulness (N = 902)	Control (N = 492)	Difference between groups
<b>Baseline</b>						
median (IQR)	52 (54)	52 (54)		64 (55)	64 (51)	
Number <sup>c</sup>	865	448		867	448	
<b>Follow-up</b>						
median (IQR)	55 (59)	52 (54)		64 (58)	64 (55)	
Number	848	449		858	449	
<b>Mean change<sup>d</sup></b>						
(95% CI)	0.6 (-0.9; 2.0)	-0.3 (-2.3; 1.8)	0.8 (-1.7; 3.2)	-2.2 (-3.7; -0.7)	-2.7 (-5.0; -0.5)	0.5 (-2.1; 3.2)
Number	887	476	1363	890	476	1366
P-value <sup>e</sup>	0.44	0.79	0.53	0.004	0.02	0.69

<sup>a</sup>Beck score was transformed to percentiles ranging from 1 to 99 using a normative population

<sup>b</sup>Mean difference in change between mindfulness and control group (mindfulness-control)

<sup>c</sup>Number of individuals included in the analysis. For mean change and difference between the groups, this is the number of individuals not lost to follow-up and data on either baseline or follow-up questionnaire, i.e. all available data is used.

<sup>d</sup>Mean change in Beck score (follow-up – baseline)

<sup>e</sup>Changes *within* group and *between* groups tested by linear mixed models adjusted for baseline score

## Mode of delivery

Stratified analyses within the intervention group were performed between the group that had the sessions mainly led by the teachers compared to the group that had the sessions mainly led by audio files. With the control group as reference, a significant reduction of symptoms of depression was seen in the teacher-led group, -7.3 ( $p=0.009$ ) and no change in symptoms was seen in the group who received the intervention via audio files, 1.5 ( $p=0.24$ ). The same trend was observed in symptoms of anxiety, where the teacher-led group decreased in symptoms, -5.5 ( $p=0.07$ ), and no change was observed in the group who received the sessions via audio files, 0.5 ( $p=0.71$ ).

The overall difference between the audio file and the teacher-led group was significant for both symptoms of depression, -8.8 ( $p=0.0001$ ) and anxiety, -6 ( $p=0.04$ ).

Change in symptoms of anxiety and depression after 10 weeks stratified by mode of delivery is presented in Table 11.

Table 11: Primary outcomes after 10-week follow-up stratified by type of intervention

	Beck score <sup>a</sup> , depression		Beck score, anxiety	
	Mean difference (95% CI) <sup>b</sup>	P-value <sup>c</sup>	Mean difference (95% CI)	P-value
<b>Ref control group</b>				
Number <sup>d</sup>	476		476	
Mainly audio file	1.5 (-1.0; 4.1)	0.24	0.5 (-2.2; 3.3)	0.71
Number	709		712	
Mainly led by teacher	-7.3 (-12.7; -1.9)	0.009	-5.5 (-11.4; 0.4)	0.07
Number	73		73	
Difference between type of intervention groups <sup>e</sup>	-8.8 (-14.1; -3.5)	0.001	-6.0 (-11.8; -0.3)	0.04
Number	1258		1261	

<sup>a</sup>Beck score was transformed to percentiles ranging from 1 to 99 using a normative population

<sup>b</sup>Mean difference in change from baseline to follow-up (compared to control group)

<sup>c</sup>Differences tested by linear mixed models adjusted for baseline score

<sup>d</sup>Number of individuals not lost to follow-up and data on either baseline or follow-up questionnaire, i.e. all available data is used.

<sup>e</sup>Difference between type of intervention groups (mainly teacher – mainly audio file)

## Paper IV

### Baseline characteristics and loss to follow up

Of the 1399 students that were included at the start, a total of 974 participants filled in the questionnaire at the one-year follow-up. A total of 240 students in the mindfulness group and 185 students in the control group were lost to follow-up (shown in Figure 6). In general, the students that were lost to follow-up were older and were less likely to live with both parents. They also scored higher on symptoms of anxiety at baseline than the students that answered the questionnaire after one year. Differences in age and anxiety between completers and non-completers were significantly more pronounced in the mindfulness group compared to the control group. However, two different sensitivity analyses were performed and showed no difference in change between the groups, i.e. our conclusions remain the same.

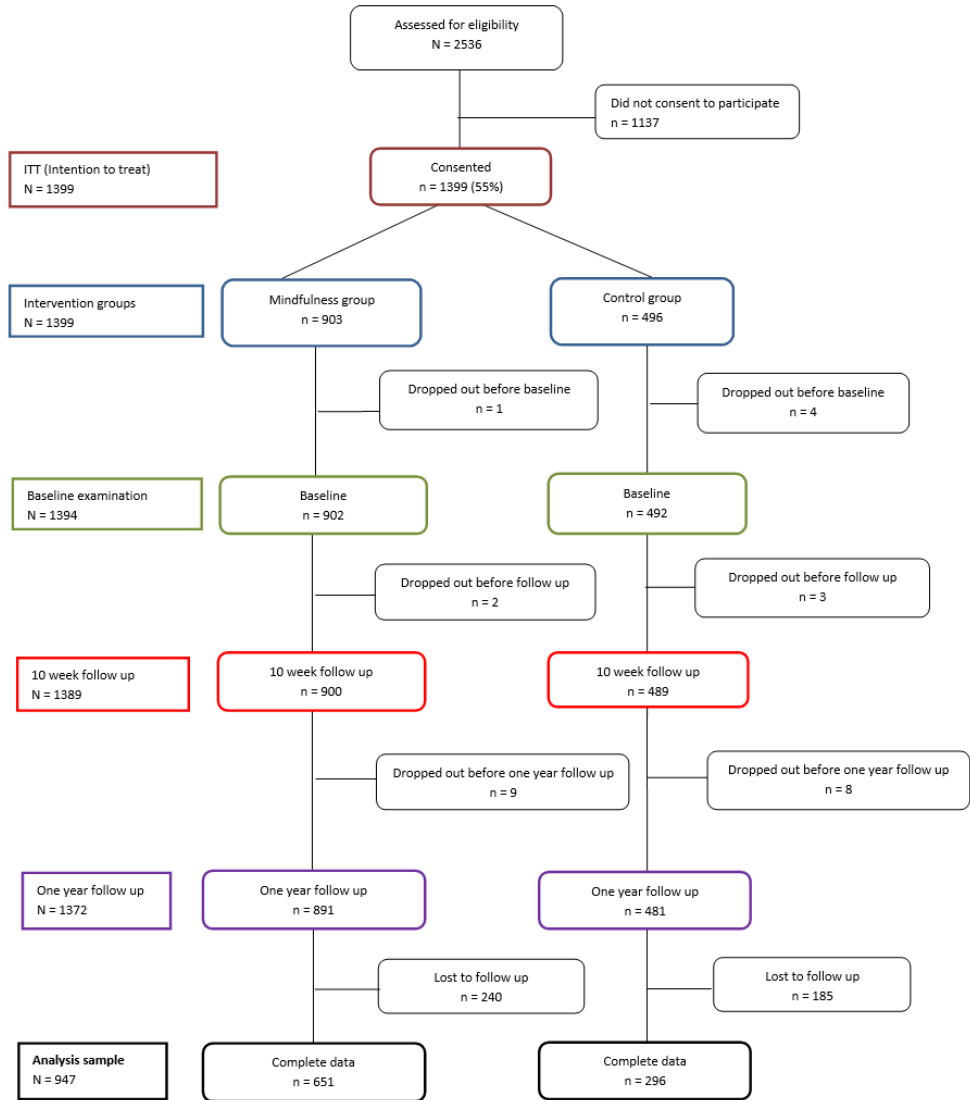


Figure 6. Flowchart for children included in the study at 10 weeks and at 1 year (school-class 3-9)

## Changes in anxiety and depression symptoms

There was no significant change in depression symptoms within the intervention group after one year. Symptoms of depression decreased slightly in the control group but were not significant. There were no significant differences between the groups after one year. Symptoms of anxiety decreased significantly in the intervention group,  $-4.1$

( $p < 0.0001$ ) and in the control group,  $-3.7$  ( $p = .01$ ). However, no significant difference was observed between the groups ( $p = 0.8$ ).

The results for changes in symptoms of anxiety and depression are shown in Table 12.

Table 12: Primary outcomes at one-year follow-up

	BECK score <sup>a</sup> , depression			BECK score, anxiety		
	Mindfulness (N = 891)	Control (N = 481)	Difference between groups <sup>b</sup>	Mindfulness (N = 891)	Control (N = 481)	Difference between groups
<b>Baseline</b>						
median (IQR)	52 (54)	52 (54)		64 (55)	64 (51)	
Number <sup>c</sup>	861	446		862	446	
<b>One year follow up</b>						
median (IQR)	52 (59)	46 (62)		59 (63)	59 (63)	
Number	626	285		623	285	
Mean change to one year <sup>d</sup>	-0.1 (-1.9; 1.7)	-1.6 (-4.4; 1.1)	1.5 (-1.8; 4.8)	-4.1 (-6.0; -2.2)	-3.7 (-6.6; -0.8)	-0.4 (-3.9; 3.0)
p-value	0.91	0.25	0.37	< 0.0001	0.01	0.8

<sup>a</sup>BECK score was transformed to percentiles ranging from 1 to 99 using a normative population

<sup>b</sup>Mean difference in change between mindfulness and control group (mindfulness-control)

<sup>c</sup>Number of individuals included in the analysis.

<sup>d</sup>Mean change in BECK score (one-year follow up – baseline)

## Mode of delivery

After one year, there was no significant difference in either symptoms of depression or anxiety between the groups in regards to the mode of delivery. Change in symptoms in regards to mode of delivery is shown in Table 13.

Table 13: Primary outcomes after one-year follow-up stratified by type of intervention

	BECK score <sup>a</sup> , depression		BECK score, anxiety	
	Mean difference (95% CI) <sup>b</sup>	P-value <sup>c</sup>	Mean difference (95% CI)	P-value
<b>Change to one year</b>				
<b>Ref control group</b>				
Mainly CD/audio file	1.5 (-1.9; 4.9)	0.39	-0.6 (-4.1; 2.9)	0.84
Mainly led by teacher	6.8 (-1.6; 15.1)	0.11	-1.9 (-10.6; 6.8)	0.35
Difference between groups <sup>d</sup>	5.3 (-2.9; 13.5)	0.20	-1.3 (-9.9; 7.22)	0.76

<sup>a</sup>BECK score was transformed to percentiles ranging from 1 to 99 using a normative population

<sup>b</sup>Mean difference in change from baseline to follow-up (compared to control group)

<sup>c</sup>Differences tested by linear mixed models adjusted for baseline score

<sup>d</sup>Difference between type of intervention groups (mainly teacher – mainly CD)

# Discussion

This section starts with a short summary of the main results of the different interventions and a discussion of the findings in relation to previous research. Methodological considerations for each of the interventions are discussed. The following sections describe the interventions in general and the key take-home messages as well as clinical implications and suggestions for future research.

## Paper I

The main finding of Paper I was that the dance intervention resulted in significantly reduced daytime tiredness in the intervention group during and after the time of the intervention compared to the control group, implying both an immediate and long-lasting effect of the intervention. In addition, self-reported alertness also increased in the intervention group at most of the follow-ups thus further strengthening the results. However, significance faded after adjusting for baseline differences in alertness at baseline between the groups.

The association between physical activity and sleep is well described (Brand et al., 2010b; De Vries et al., 2016; Lang et al., 2013; Lang et al., 2016) however, up to date, this is the first study investigating the effects on tiredness after a dance intervention.

It has been previously described how low-intensity running promotes sleep quality and fatigue among adolescents (De Vries et al., 2016), and that adolescents with higher levels of physical activity showed less daytime tiredness, improved concentration, improved sleep quality as well as lower levels of depression and anxiety than less physically active individuals (Brand et al., 2010a, 2010b). It was also found that the physically active adolescents showed a shorter sleep onset latency based on EEG-measures (Brand et al., 2010a), which strengthens the finding of improvements in the “easier falling asleep” item shown in the intervention group in our study.

However, the dance intervention performed in this study was more multifaceted than most other interventions with physical activity, involving key elements important for increasing mental health among the girls. It should be noted that daytime tiredness can

be a result of insufficient sleep, but it could also be a symptom of overall stress and mental health complaints. This goes hand in hand as mental health problems and sleeping problems often co-exist (Qiu & Morales-Muñoz, 2022), and the association is most probably a reciprocal rather than a unidirectional pattern. It should also be addressed that sleeping problems and mental health complaints may share some important underlying mechanisms in terms of biological, psychological, and social aspects such as HPA-axis dysregulation, inflammatory cytokines, rumination, worry as well as troublesome social functioning (Blake et al., 2018).

A bi-directional association between sleep disturbances and mental health were found in a prospective cohort study of 1689 individuals followed from the age of five (Marino et al., 2022). Having started already in childhood, a developmental cascade was suggested where sleep problems and mental health problems negatively influenced each other (Marino et al., 2022). Similar findings have previously been described, where sleep disturbances in childhood seemed to predispose individuals to the development of mental health problems (Alvaro et al., 2013). The importance of finding interventions to break this trend as early as possible was highlighted (Marino et al., 2022). Some effects of non-pharmacological sleep interventions on mental health problems were found in a meta-analysis covering the topic (Gee et al., 2019). However, the pooled effect size was smaller among adolescents than adults, interventions mainly included CBT in different formats as well as self-help programs delivered online or via mobile applications, and none of the interventions included physical activity (Gee et al., 2019).

It was also shown that the dance intervention performed in this study also resulted in improved self-rated health (Duberg et al., 2013) as well as a decrease in emotional distress and reduced stress-related somatic symptoms (Duberg et al., 2020). In addition, the girls reported an enhanced feeling of companionship and togetherness (Duberg et al., 2016). As both psychological distress (Gustafsson et al., 2018a) and loneliness negatively affect sleep (Lyyra et al., 2018), it might be possible to ascribe some of the intervention's positive effects on daytime tiredness to be a result of improved general health including an upward spiraling effect in a variety of outcomes.

Sleep duration was reported equally in both the intervention group and the control group. Both groups reported a sleep duration of between 6-8 hours, which is defined as normal in recommendations (Hirshkowitz et al., 2015) and this did not change in either of the groups during the study period. Neither De Vries (De Vries et al., 2016) or Brand (Brand et al., 2010a, 2010b) found any correlation between activity levels or sleep duration, which indicates that improved sleep quality is not necessarily associated with longer sleep duration.



No significant improvement in school satisfaction was shown after adjustments for baseline differences between the groups, and no correlation between school satisfaction and reduced daytime tiredness was seen in our sample. A cross-sectional study of adolescents aged 11-17 years old showed that girls in general had lower school satisfaction than boys. Experiencing morning tiredness was also negatively associated with school satisfaction. Both teacher and peer support, as well as experience of fairness in school, were correlated with higher school satisfaction whereas academic achievement was not (Saleh et al., 2019). It was previously shown that objectively measured sleep quality is associated with school achievement, however subjectively reported sleep quality and reported tiredness did not correlate (Tonetti et al., 2015). School satisfaction is an important matter for adolescents and needs further investigation. The association between mental health, sleep and school satisfaction has not been fully researched, and should be highlighted and prioritized in future research, especially after the Covid-19 pandemic which has contributed to changes in school environment and structure, as well as health behaviors and mental health problems among young people worldwide.

### **Strengths and limitations**

Strengths of this study include the longitudinal randomized design as well as an extensive intervention time period and long-term follow-up. The novelty of the intervention is another strength, adding to the evidence of non-pharmacological interventions for improving mental health including daytime tiredness and sleeping problems. It further highlights the possibilities of positive spillover effects on emotional and somatic symptoms when mental health problems are addressed and worked with. In addition, the dance intervention was shown to be cost-effective (Philipsson et al., 2013).

A limitation, however, is the use of self-reported data solely. To get a wider understanding of sleep quality and patterns, objective measures could have been used such as EEG. Other biological markers, such as cortisol and inflammatory markers, could be used to widen the understanding about the common underlying mechanisms of mental health problems and sleeping problems. Results from this study cannot rule out if the improvement in sleep is determined as a result of physical activity or dance or due to an overall improvement in mental health and life satisfaction. The imbalance of baseline variables is another limitation. Unfortunately, the girls in the control group showed lower levels of alertness and school satisfaction, which leads to greater room for an improvement in this group. No conclusive results regarding alertness and school satisfaction could be made after adjustments. Only adolescent girls were included in

this study, and more research is needed to generalize the findings from this study to boys and girls in other age groups.

In conclusion, results from this study showed significant improvements in reduced daytime tiredness among the participants in the dance intervention group. Although more randomized controlled studies are needed to further investigate and evaluate the effect of dance interventions in different settings and to different target groups, this study shows promising results of being an alternative and complementary non-pharmacological method for improving mental health among adolescents.

## Paper II

The aim of Paper II was to investigate the effects on cortisol in saliva among girls with FAPDs during and after an 8-month intervention with dance and yoga. Findings from the study showed improvements in saliva cortisol values during the time of the intervention among participants in the intervention group, implying a stress-reductive effect. However, improvements in cortisol did not remain at the end of the study and will be discussed further.

Disrupted cortisol levels can have many causes. Stress can cause alterations in the HPA axis following cortisol release, and low levels of cortisol have been shown to predict depression in adolescent girls (Schuler et al., 2017). However, even though FAPDs might be associated with stress and mental health, cortisol levels among children with FAPDs are not fully understood. Two previous studies have pointed towards increased morning cortisol values and higher total cortisol secretion among children with FAPDs (Tornhage & Alfvén, 2006, 2015). However, the general knowledge about cortisol levels in this target group is limited. Even though the changes in cortisol levels were not statistically significant at the end of the study, our measured baseline values contribute to a wider understanding of FAPDs and their underlying pathophysiology in this research field. The median baseline cortisol value in our sample was 10.5 nmol/L in the morning and 1.1 nmol/L in the evening, which represents normal reference levels according to previously described measures from healthy individuals in the same age group (4-27 nmol/L in morning and 0.7-7 nmol/L in evening (Michels et al., 2012). The normal values at the start make the potential room for improvement small and the possibility to achieve significant changes is reduced. To gain a broader understanding, a third control group with healthy individuals would have been of importance.

It should also be noted that intraindividual variations in cortisol levels are large. In order to account for difference between individuals, we analyzed the evening/morning

quotient. This method has been previously used (Ivars et al., 2015), however, since no gold standard in reporting and analyzing cortisol values exist, the comparison between studies is limited (Jessop & Turner-Cobb, 2008).

A small improvement was seen in cortisol levels among second graders but not third graders after a 10-week intervention with yoga performed during school hours in a classroom setting (Butzer et al., 2015). However, the study was small and contained no control group. In addition, only one single value was analyzed, thereby not reflecting the diurnal pattern. Some improvements in cortisol awakening response were seen in a small study investigating the effects of an aerobic dance intervention among participants aged 18-20 years (Ramanian et al., 2020). However, this improvement was only seen in the group who were allowed social interaction during the classes and who performed the intervention outdoors instead of indoors. The social aspects were discussed as an important influencer of the results, however, the study was very small, and since the subjects were healthy individuals older than the participants in our study, the results should be compared with caution. Another study among economically disadvantaged children aged 3-5 years showed improvements in cortisol levels after one year of art classes including dance. Improvements were seen during and after the but not at the beginning of the study (Brown et al., 2017).

Interestingly, the major effects on cortisol values in our study were seen at four months in the intervention group and did not remain towards the end. At the end of the study, morning cortisol values were significantly reduced in both the intervention group and the control group, which resulted in an increased cortisol quota in both groups. Cortisol sampling in saliva mirrors a point value of cortisol levels and intraindividual day-to-day fluctuations can be large. High levels of stress during the day before sampling can influence morning cortisol values the next coming day (Angelhoff et al., 2019; Proulx et al., 2017). It is not likely that the participants experienced more stress during the third sampling than the first related to knowing the sampling procedure. However, the 8-month sampling was done in May-June, a potentially stressful time for all students. Seasonal fluctuations could be another contributing factor that is not investigated enough. The 8-month sampling was also performed during the same time as the intervention was about to end, which could contribute to stress among individuals in the intervention group and increased worry due to uncertainty of the time after the intervention. Breaking up a safe and social group might increase the feeling of loneliness, which can lead to stress and affect cortisol levels negatively (Zilioli et al., 2017). Age and pubertal timing could also be potential influencing factors (Tornhage & Alfvén, 2006). This was not adjusted for in our sample, however, age and menarche were comparable in our study groups, and we assume that the potential hormonal influence on cortisol levels was comparable between the groups. Weight might also

influence cortisol levels. One previous study has indicated that salivary cortisol is negatively influenced with BMI in children with abdominal pain (Tornhage & Alfvén, 2006). A larger amount of the girls in the intervention group were overweight compared to the control group but there were no significant differences in mean BMI.

Abdominal pain decreased significantly in the intervention group compared to the control group throughout the study (Högström et al., 2021). Yet, no difference in median the evening/morning quotient was observed between the individuals who reported a decrease in abdominal pain compared to the individuals who did not decrease in abdominal pain. Neither were there any associations between perceived stress nor change in cortisol. However, the study sample was very small in this analysis and should be interpreted with caution.

### **Strengths and limitations**

The key strength of this study is that it contributes to the wider understanding about cortisol levels in children with FAPDs. Methodological strengths involve the randomized controlled design as well as the length of the intervention and the use of objective measures to provide new insights about this vulnerable target group and the potential effect of health-strengthening interventions. Saliva samples were collected at home, which contributed to a non-invasive and easy sampling method with little stress related to the sampling procedure. The participants and their parents received written and orally given information about the procedure but we cannot confirm how precisely the participants followed the given guidelines.

Some methodological limitations should be addressed and further improved in future studies. First, our study only involved two saliva samples per day and thereby does not allow us to investigate the cortisol awakening response. Furthermore, the sampling was only performed during one single day. To gain a fuller understanding, measures could have been taken during more days to account for daily fluctuations. Measurements could have been complemented with hair cortisol to get a broader understanding about the cortisol secretion over time. It should be noted though that hair cortisol does not provide any information about the diurnal pattern and could not replace the measures used in this study but could only provide important complementary information.

Another limitation of this study was the sample size. The power calculation was performed based on abdominal pain, which was the primary outcome of the study. It is possible that the power in relation is underestimated and that some results would differ if the sample size were larger, especially in the subgroup analyses of individuals within the intervention group related to abdominal pain and stress. More research is

needed to confirm the results as well as to further generalize our findings to a larger target group. A third study group with healthy individuals would have been necessary to compare the results found in this study with individuals without FAPDs.

Our findings did not show any significant difference between the intervention group and the control group at the end of the study. Improvements were seen halfway through the intervention, which might imply a positive effect during the intervention. Objective measures such as cortisol can contribute to a wider understanding about the underlying pathophysiological mechanisms in FAPDs. However, this needs to be further investigated in future studies.

## Paper III and paper IV

In Paper III and Paper IV, we evaluated a mindfulness intervention with short mindfulness sessions performed in the school classrooms. Overall, the mindfulness intervention did not show any effect on depression and anxiety symptoms among the students after 10 weeks or after one year. However, interestingly, sub-group analyses of the individuals who received the teacher-led sessions showed a significant reduction in depression and anxiety symptoms after 10 weeks compared to the students who received the intervention via audio files. The difference in outcome in the teacher-led group did not remain after one year.

Using mindfulness practice in schools has gained popularity all over the globe during the last decade (Dunning et al., 2019; Hayes et al., 2019; K. Kallapiran et al., 2015; Kuyken et al., 2022; Kuyken et al., 2017; Perrier et al., 2020). Even though mindfulness interventions have shown some positive effects in domains such as enhancing resilience and stress-coping skills (Fenwick-Smith 2019, Zenner et al., 2014), and partially effective in improving depression and anxiety symptoms among children and adolescents (Kannan Kallapiran et al., 2015; K. Kallapiran et al., 2015; Zenner et al., 2014, Dunning 2019, Odgers et al., 2020; Ruiz-Íñiguez et al., 2020; Raes et al., 2014; Johnson & Wade, 2019), the implementation of mindfulness as an effective intervention in school settings has been questioned (Dunning et al., 2022). Just like in our study, no effects were seen after a teacher-led mindfulness intervention in schools, and even pointed towards worsening in some outcomes post-intervention as well as at the one-year follow-up (Kuyken et al., 2022)

It should also be noted that the effects of mindfulness on symptoms of depression and anxiety and other mental health conditions have mainly been observed in clinical settings among adolescents diagnosed with either depression or anxiety disorder

(Zoogman et al., 2015). In a recent meta analyse, mindfulness showed effects on depression only in selected interventions (Dunning et al., 2022). Just like in other universal studies, the ceiling effect could partly contribute to the lack of findings. This has been described not only in mindfulness studies but also in other universal school-intervention studies that evaluated the effect on mental health problems, since school students in general show low baseline values in these outcomes (Fenwick-Smith et al., 2018; Schmidt et al., 2020).

The aim of this study was to investigate the effect of an easily applicable mindfulness intervention, which was integrated into the school schedule, and delivered by the schoolteachers, as an alternative to more comprehensive methods delivered by external instructors that interferes with normal schoolwork.

Prior to the study commencing, the schoolteachers were equipped with a mindfulness instructor course to be able to lead the mindfulness practice themselves in the classroom. Using the schoolteachers instead of external instructors was a conscious choice made to lower barriers, lower costs and to also be more flexible to fit mindfulness practice into the school schedule when appropriate. It has been previously described that interventions in school settings show a greater effect on mental health outcomes when delivered by a school teacher instead of external instructors, probably due to familiarity with the students (Carsley et al., 2018). It has also been shown that adaption of the intervention is a key factor for a positive outcome (Fenwick-Smith et al., 2018), and that this would probably be more likely if the instructor has previous knowledge of the students in the room. However, the mindfulness skills and the engagement of the instructor are of vital importance for the effect of the intervention (Kenny et al., 2020), and it is possible that the previously given instructor course was too brief to equip the teachers with enough knowledge and confidence to engage and deliver mindfulness practice in a confident and relaxed manner. Only 16% of the teachers chose to deliver the sessions themselves, whereas a majority of the teachers decided to use the pre-recorded audio files. Using audio-files has been proven to be feasible in previous studies (Bakosh et al., 2016), however, larger effects were found in interventions when sessions were provided with face-to-face guidance (Blanck et al., 2018). Reasons for why the teacher chose one method over the other were not investigated but could be many. It could be due to practical reasons; i.e. that they did not have enough time to prepare the sessions. It could also reflect an overall high-stress level among the teachers, or the lack of confidence to provide the sessions themselves. It should be noted that for many of the teachers this was their first encounter with mindfulness, and it is possible that their comfort and experience would increase over time if they continued to practice and provide mindfulness, in particular with continued education and self-practice.

Since the mindfulness intervention was partly added to normal schoolwork without an exchange of normal school activity, it is also possible to believe that the intervention added to already high stress levels among the teachers and the students. The stress and workload among teachers is already high. It is not impossible to believe that high-stress levels among teacher negatively influences mental health among students. Before implementing more activities and interventions in schools, it should be of the highest priority to reduce the overall stress level among teachers and other school staff. The experience of being overwhelmed by workload is a common barrier for the implementation of health- strengthening interventions in school settings (Shoosmith et al., 2021). In addition, an overall high-stress level among teachers will most probably affect their capacity for self-regulation and co-regulation of the students in their classroom (Murray et al., 2019); it is of uttermost importance to build a supportive classroom climate, especially when working with interventions to promote children and adolescents' mental health. Teachers must first be able to self-regulate themselves before being able to also meet these needs among the students (Murray et al., 2019). It is impossible to believe that any intervention could counterpart the negative effects if, in general, the school environment is unhealthy. Mindfulness interventions given to teachers have shown beneficial effects in stress-related outcomes (Taylor et al., 2021). However, the studied intervention focused solely on teachers and did not involve any elements of further instructing mindfulness for their students.

The positive outcome seen in the teacher-led group did not remain after one year. Even though some studies on mindfulness show a sustained, and sometimes even increased effect over time and also after the end of the intervention (Johnson & Wade, 2019; Klingbeil et al., 2017; Raes et al., 2014), this was not seen in our sample.

It is more likely to be that interventions need to be ongoing or carried through during a longer period of time to gain sustainable behavioral changes and to shift mindsets among the students. In a systematic review of interventions aimed to improve resilience, the intensity and the length were observed to be key factors in favor of the length of the intervention. Furthermore, a positive effect was not observed in long-term follow-ups after most programs in many of the studies (Fenwick-Smith et al., 2018). Due to this, it might have been better to have longer and more intense mindfulness classes during a longer period of time, or to provide the students with inspiring and motivational home practice sessions to keep up with mindfulness training on their own.

The gender differences in our sample were pronounced. The older girls showed the largest amount of depression and anxiety symptoms. Symptoms remained high, both in the intervention group and the control group, especially in depression scores that seemed to rise during the intervention time. Boys, who also scored generally lower at baseline, decreased significantly in both depression and anxiety symptoms from

baseline to the one-year follow-up. A pronounced difference was observed in depression scores among boys after one year, where the control group decreased significantly more than the boys in the intervention group. This also gives a hint that boys and girls not only show different patterns in mental health problems, but also might respond differently to mindfulness training. Some mindfulness interventions describe a better response among female participants than males (Kang et al., 2018; Lassander et al., 2021; Volanen et al., 2020). Since girls in general have a larger tendency to internalizing problems (Yoon et al., 2022) such as rumination and worry, it is not unlikely to believe that they also benefit more from interventions focusing more on introspection. By contrast boys, who generally have more externalizing problems, (Yoon et al., 2022) would potentially benefit more from active interventions such as physical activity. Mindfulness interventions focusing solely on boys are sparse, and if mindfulness would be unsafe or even be contraindicated among boys is still to be ruled out in future studies.

### **Strengths and limitations**

A key strength of the mindfulness study is that it investigates the effects of a novel intervention, and a brief mindfulness alternative, that uses schoolteachers instead of external facilitators. Mindfulness performed in this way could bypass many of the barriers to large-scale implementation and thereby reach out to many students at a fairly low cost, without compromising daily schoolwork. This could constitute an easily applicable intervention, thus suggesting high applicability. We would also highlight the strength of no findings in the audio-file led group since it highlights the importance of teacher engagement, and sheds light upon what works and what does not so that future intervention studies can focus more on these factors and resources can be utilized in the most beneficial way. It also highlights the importance of a continuation of resilience-building interventions over time instead of short time interventions. This is the first study of its kind performed in a school setting in Sweden, the study was relatively large, involving participants of varying ages and different socioeconomic backgrounds.

The major limitation was the risk of selection bias, even though analyses of baseline characteristics in both groups were similar and groups should be comparable, at least in the 10-week analyses. At the one-year follow-up, there was a significant difference where the students that were lost to follow-up in general scored higher levels of depression and anxiety symptoms at baseline. It is possible that those who were lost to follow-up would have shown greater effects of the intervention and thereby modified the result. Sensitivity analyses indicated that these differences did not affect the results



but should be kept in mind. Future collection of long-term data needs to consider students' moving and change of schools in order not to lose participants over time.

It was more difficult to recruit participants to the control group than the intervention group, which resulted in a difference in group size. A “rub-off” effect could be a result of including both intervention and control classes at the same schools. On the other hand, it decreased the risk of selection bias on a school level. It should also be mentioned that the BECK scales are used to measure mental health symptoms, and if baseline values are low, there is a risk for a ceiling effect. Other questionnaires are needed to rule out other aspects of mental health as well as resilience factors. Since the BECK scales focus on mental health symptoms, some students might have experienced discomfort and anxiety by filling in the questionnaires.

The lack of availability of facilities and equipment, space as well as funding and organizational support has been reported as the main barriers for implementing health improving interventions in school settings (Shoesmith et al., 2021). Since mindfulness has been shown to have a positive effect in a variety of outcomes and holds promise to be an easily applicable and feasible intervention that is manageable to carry through without additional costs and required space, it is not unlikely that mindfulness could be an appropriate alternative for improving mental health among students. However, it needs to be evaluated further, to find the most applicable way as well as timing to further rule out for whom and with what duration mindfulness should be given. There is a risk that enthusiasm for mindfulness surpasses the evidence, and further research is needed to rule out how, when and for whom mindfulness interventions can be beneficial (Dunning et al., 2022). Results from this study only show that mindfulness was beneficial when the sessions were provided with face-to-face guidance, and only in follow-ups immediately after the intervention and not in long-term follow-ups.

# Conclusion of the thesis

The paper in this thesis covers different non-pharmacological methods for improving as well as treating mental health problems and associated symptoms among children and adolescents as complementary interventions to school health systems and health care. In general, a positive outcome as well as cost effectiveness were seen in the targeted interventions prior to the universal intervention carried out in the school setting. This is in-line with previous studies, showing larger effects on targeted interventions compared to universal measures of mental health aspects (Mihalopoulos & Chatterton, 2015; Schmidt et al., 2020). Some other important factors make the dance and yoga intervention different from the mindfulness intervention and would potentially play an important role in the outcome difference.

- First to mention is the role of the instructor, which plays an important key factor. Engagement of the instructor is vital for a positive outcome of the intervention (Kenny et al., 2020), and it is possible that the instructors in the dance and dance and yoga intervention were better at providing a safe and inspiring setting for the participants since they were more skilled and had greater previous experience of being instructors than the schoolteachers had.
- Second is the social factor that has been discussed earlier in this thesis and emphasized the positive aspects of being together in a group. The dance and yoga interventions had a greater focus on social engagement, which might mirror the importance of the contribution of a group dynamic. Even though the mindfulness sessions were provided in a group setting, mindfulness focuses solely on interpersonal and not intrapersonal processes.
- A third aspect could be ascribed to a potential difference in perceived demands. The dance and yoga classes were developed with the SDT as core principles. A focus on enjoyment as well as playfulness was encouraged to limit as much outer pressure as possible, and no performance was expected. Even though the mindfulness sessions included the practicing of a nonjudgmental and self-compassionate approach, it might be that mindfulness in itself was perceived as demanding as it involved concentration, focus and sitting still.

- Lastly, the dance and yoga intervention included body movement, which in addition to the known benefits of physical activity, also might help the students to stay focused and engaged during the practice. Referring to the decline of focus and attention span is a hot topic in today's society. This statement, however, has not been verified in any longitudinal studies, and seems to be more of a disturbing notion than scientific truth. Anyhow, even though mindfulness itself can be a promising tool for increasing attention and focus (Slattery et al., 2022), it is not unlikely to believe that mindfulness practice is initially perceived to be slow and that individuals tend to zoom out and thereby miss out on its positive effects.

In this thesis, measures were collected mainly through self-reports. Even though self-reports are valid measures among children and adolescents, more research should emphasize the qualitative aspects as well as objectively observable measures. Qualitative measures help us to gain a wider understanding about children's and adolescents' own experience of their mental health complaints as well as what they need in order to meet them. The use of qualitative measures would enrich the work in this thesis by adding important information and valid aspects, which are not otherwise possible to capture in words. This would also provide information about the participants' experience of what works and what does not, hence so that the intervention could be further adapted to the students' needs. Objective measures hold the potential to widen the understanding about common biological markers as well as risk factors for the development of disease and mental health complaints, as well as understanding how non-pharmacological interventions might work on a physiological level. In this thesis, only one objective measure including cortisol in saliva was used. The knowledge about the association between mental health and inflammation is growing. A positive bi-directional link between inflammation and depression (Colasanto et al., 2020) has been observed also among children and youths, and opens the curiosity to include inflammatory markers as objective measures in interventions targeting mental health. In addition, the development of high-resolution fMRI provides new possibilities for measuring the functioning and structure of the brain and plays an important role in understanding the role of stress, mental health and the possible underlying mechanisms from a neurophysiological perspective. It should be addressed though that the use of all invasive measures requires specific ethical considerations among young people and should be carefully planned and thought through.

Mental health problems are rising among young people globally, and this thesis sheds light on possible ways to address these problems in early interventions. There is a need for both building resilience to stress and preventing the development of mental health problems early in life (Lund et al., 2018), as well as finding easily applicable and cost

beneficial interventions to target children and adolescents at risk of or already manifested mental health complaints, which otherwise may contribute to important consequences during a long life span (Wolitzky-Taylor et al., 2014).

Our society is evolving rapidly towards digitalization, which might open up new possibilities. However, digitalization might also contribute to individualization, social distance and loneliness with fatal consequences for mental health, especially among young people. Digitalization also risks increased screen time and less physical activity, which further highlights the importance of interventions that can motivate and stimulate physical activity. Medical science reveals important understanding and knowledge about the treatment of previously life-threatening diseases. The average life expectancy will most probably increase in the coming years, however, in order to maintain life quality, mental health needs to be maintained.

New light is also being shed on the relationship between inflammation and mental health problems (Colasanto et al., 2020). Inflammation seems to play an important role in both mental health problems (Colasanto et al., 2020) as well as sleep (Park et al., 2016) and pain syndromes (Vinall et al., 2016). Cortisone is one of the major stress hormones and plays an important role in the inflammatory response. It is well known that prolonged stress induces disruption of cortisol release. The interest in testing anti-inflammatory drugs in the treatment of mental health disorders is growing (Köhler et al., 2014). Furthermore, the vagal nerve plays an important role in the inflammatory response, and vagal nerve stimulation has been found to have an anti-inflammatory effect (Bonaz et al., 2016). All intervention studied in this thesis included elements with vagal nerve stimulation, such as breathing exercises and relaxation. To further test this, more biomarkers linked with inflammation, such as CRP or interleukin could be used in future research.

However, it should be noted that using more invasive methods such as fMRI or blood sampling constitutes a greater ethical consideration especially among children and needs to be carefully considered. Anyhow, carrying out research among young people needs to be accompanied with special ethical consideration. It is important to make sure that the research gains scientific weight and that the risk of potential harm is minimized. Yet, research is important to bring science forward, and including also young people is necessary also to gain knowledge about the best treatment options also for young people. On a societal level, using non-evidence based methods and interventions would be unethical in the long run, not using sparse resources in the best potential way. The included studies are designed to evaluate existing gaps in knowledge and to investigate potential new ways to help and treat and prevent mental health problems among young people in future. In the long run, this would hopefully be beneficial from an individual level as well as a social level.

## Clinical and societal implications

Mental health problems are increasing worldwide among adolescents and youths, which calls for action finding, supportive and preventive interventions that could be implemented on a large scale at low cost. Reports show an increase in SSRIs in Sweden (Lagerberg et al., 2019) and Europe (Dai Cao et al., 2021; Tiffin et al., 2019), even though SSRIs are not suggested as first-line therapy (Luxton & Kyriakopoulos, 2022). Antidepressants are often prescribed off-label, especially among children. Even though there is a lack of evidence in regard to pharmacological treatment for children with abdominal pain, this is not the case in clinical practice. Manufacturing and administration of pharmaceuticals also has an environmental impact that should be addressed and should thereby be limited to cases where there is a substantial need for it. Accessibility for psychological treatment is low, and alternative therapies with high availability and feasibility that can be implemented on a large scale with a lower cost are needed.

The positive benefits of being together in a supportive group are suggested to be a key factor for the positive outcome, especially in the dance intervention and in the dance and yoga intervention. This should be acknowledged and highlighted in future research as well as in societal interventions and clinical practice, especially in times where digitalization and global development contribute to an increased risk for social isolation and loneliness, which are significant risk factors for the development of mental health problems.

In addition, early interventions are needed to prevent the risk of sustained mental health problems and increased individual and societal costs. Due to inability to meet the increasing demands, there is a need for preventive universal interventions as well as targeted interventions for high-risk individuals and individuals with already manifested symptoms. A close collaboration between the school health system as well as the children and youth healthcare system is suggested.

Through school-based interventions, performed as targeted or universal, accessibility could be increased, and more students could be reached. In addition, school-based interventions would decrease the cost for individuals and families, prevent travel times and could potentially reduce stigma around mental health problems, which all could represent potential barriers for children and adolescents with or at risk for developing mental health problems. In this thesis, we found support for the targeted interventions with dance for adolescent girls with internalizing problems, and dance and yoga for younger girls with abdominal pain. No general effects were seen in the universal intervention with mindfulness in the school classroom, except for the small group who

received the sessions teacher-led instead of guided via audio files immediately after the intervention. The difference in outcome in regard to the mode of delivery needs to be further investigated.

The health economic effects of universal methods for reducing mental health problems in a universal setting are still questioned (Schmidt et al., 2020). A lack of findings has been discussed as a result of the ceiling effect, a potential bias in universal studies where baseline levels in general mental health problem are low. Both the dance intervention and the dance and yoga intervention were proven to be beneficial as regards of health economics (Philipson, 2022), which further strengthens their role as useful interventions in clinical practice.

Lastly, the interventions included in this thesis also hopefully could inspire the development of future planned studies on complementary ways to improve mental health among youths.

## Suggestions for future research

Further research in the field of preventing and promoting mental health problems among children and adolescents is needed, and by the conclusions of this work I suggest;

- To further investigate risk factors and resilience factors among children and youths and the development of mental health problems, and to further investigate the gender difference in the prevalence and presentation of mental health problems.
- To find better ways of finding children and adolescents at risk and with early symptoms of stress-related and mental health problems and with easily applicable and feasible interventions to decrease the risk of development for future health problems.
- Further investigate the effects of dance and yoga as a treatment option for children with abdominal pain, and how it could be implemented in clinical practice, and add to the research with similar activities for boys with abdominal pain.
- Investigate the effects of dance and yoga for children with other chronic pain syndromes as well as stress-related problems.

- To further investigate the school environment and what changes can be made to decrease the risk of stress-related and mental health problems among students. In addition, investigate the mental health and stress factors among teachers and how it affects the mental health and stress levels among students.
- To further investigate the barriers experienced by the teachers to provide interventions addressing mental health problems in the classroom and in the school setting.
- Further investigating the effects of teacher-led mindfulness in the classroom and its potential effects on mental health outcomes among the students in short and long follow-up. Also investigating the effect of ongoing mindfulness intervention instead of short time interventions.
- Investigating other classroom-based interventions, such as breathing, yoga or physical exercise and their potential effects in comparison with mindfulness, to find suitable interventions with the potential to utilize resources in the best way.
- Addressing the gender differences in response to the mindfulness intervention, and how it could be tailor-made to suit both boys and girls in short and long-term follow-ups.
- In general, complement research with self-reported data with objective measures such as HRV, blood sampling of inflammatory markers and fMRI to get closer to the pathophysiological changes in mental health problems and psychosomatic problems, to aim for finding early signs and risk factors as well as further understanding the physiological effects of alternative treatments.

# Sammanfattning på Svenska

Den psykiska ohälsan stiger bland både vuxna och barn nationellt och globalt, och anses vara en av vår tids största hälsoutmaningar. I begreppet psykisk ohälsa innefattas både lättare psykiska besvär samt psykisk sjukdom. Framför allt psykiska besvär är inte sällan orsakade av stress, och har länge varit överrepresenterade bland flickor. De senaste åren har psykiska besvär ökat även hos pojkar, och den proportionella ökningen av psykiska besvär har varit större hos pojkar än hos flickor. Psykisk ohälsa beror både på medfödda och miljömässiga faktorer och innefattar såväl psykiska besvär såsom nedstämdhet, oro, trötthet, sömnbesvär som kroppsliga besvär såsom buksmärta och huvudvärk. Symptom på ångest och depression är också vanligt förekommande, men ska inte förväxlas med manifesterad ångest eller depressionssjukdom som ofta kräver en annan typ av behandling. Att drabbas av psykisk ohälsa tidigt i livet kan få flera konsekvenser på kort och lång sikt. Utöver de akuta riskerna i form av sänkt livskvalité, ökad skolfrånvaro och utanförskap finns också en ökad risk för både psykisk och kroppslig sjukdom senare i livet. Det finns därför ett stort behov av att hitta metoder som både kan behandla, men också förebygga psykiska besvär så tidigt som möjligt.

Eftersom läkemedel inte bör användas vid behandling av psykiska besvär utan enbart ges till individer med svårare psykisk sjukdom har intresset för att hitta alternativa metoder som fokuserar på individens friskfaktorer i form av fysisk aktivitet, avslappning och stresshantering ökat de senaste åren. Dans, yoga och mindfulness är exempel på sådana metoder. Dans och yoga är populära aktiviteter, framför allt bland flickor, och har visat sig kunna stärka psykisk hälsa hos ungdomar. Utöver de positiva effekterna av ökad fysisk aktivitet har dans visat sig kunna öka emotionell reglering och kroppsmedvetenhet. Yoga ökar kroppskännedom och avslappning. Mindfulness har blivit en populär metod för ökad avslappning och stresshantering hos både vuxna och barn, och har visat sig möjligt att implementera i en skolmiljö. Mindfulness ökar medvetenheten kring tankeprocesser och känslor och kan därmed minska stresskänslighet. Alla tre metoderna har alltså visat sig kunna förbättra självreglering, vilket innebär en förbättrad förmåga att i stressade situationer kunna reglera sina känslor och tankar och därmed styra sitt beteende och handlingar på ett gynnsamt och hållbart sätt. Ökad självreglering har i många studier visat sig vara associerat med bättre hälsa.



I den här avhandlingen har vi tittat på tre interventioner med dans, yoga respektive mindfulness. Samtliga riktar sig till barn och ungdomar för att antingen behandla eller förebygga psykiska besvär. Eftersom psykiska besvär länge har varit överrepresenterade hos flickor riktades de två första studierna enbart till flickor. I den första studien studerades effekten på trötthet och sömnbesvär efter en åtta månader lång intervention med dans för tonårsflickor med olika typer av psykiska besvär. I den andra studien studerades stress och kortisolnivåer hos flickor med återkommande buksmärta efter en åtta månader lång intervention med både dans och yoga. Den tredje interventionen studerade mindfulness i skolan, och inkluderade både pojkar och flickor i skolklasser i mellan- och högstadiet. Här studerades hur graden av depressions och ångestsymptom påverkades efter en tio veckor lång intervention med dagliga korta mindfulnessövningar i klassrummen. Mätningar gjordes direkt efter avslutad intervention och efter ett år.

De två första projekten visade på positiva resultat. Dansstudien visade inte bara på förbättrad självskattad hälsa, men också minskad dagtrötthet hos flickorna. Dans- och yogastudien pekade mot förbättrade kortisolnivåer under interventionens genomförande. Effekten kvarstod dock inte vid interventionens slut. Studien av mindfulness i skolan visade inte någon effekt på elevernas ångest och depressionssymptom, förutom i en liten grupp av individer där lärarna ledde mindfulness-sessionerna själva istället för med hjälp av inspelningar. Däremot fanns inga skillnader mellan mindfulnessgruppen och kontrollgruppen vid mätningen efter ett års tid.

Överlag visade resultaten från samtliga studier en bättre effekt vid de riktade interventionerna till flickor med psykiska besvär än vid interventionen som gavs till hela skolklasser. Detta är i linje med tidigare studier där man sett att riktade interventioner ofta är mer gynsamma än så kallade universella metoder som riktar sig till en större grupp både med och utan besvär. Å andra sidan kan detta ifrågasättas, eftersom det finns metodologiska svårigheter med att mäta psykiska besvär i en normalbefolkning, där många av eleverna har ett generellt högt välmående.

Mer forskning behövs för att hitta välfungerande och kostnadseffektiva metoder för att bryta trenden av ökade psykiska besvär hos barn och unga. Dans och yoga kan potentiellt vara effektfulla interventioner till flickor med psykisk ohälsa, men mer forskning behövs för att kunna generalisera resultaten till andra åldersgrupper samt till pojkar. Baserat på studierna i denna avhandling kan mindfulness i klassrummen, så som den praktiserats i denna studie, inte direkt rekommenderas som en insats för att motverka psykisk ohälsa hos skolelever. Mer forskning behövs för att hitta fungerande och användbara metoder som kan förebygga och behandla psykisk ohälsa, gärna med möjlighet att kunna appliceras enkelt på gruppbasis i skolmiljö.

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