Is Recovery a Monthly Rollercoaster? How Menstrual Cycle Phases Affect Engagement in Recovery Activities and the Impact on Psychological Detachment.

Ermioni Styliani Vosnaki (i6362542)

Faculty of Psychology and Neuroscience

Maastricht University

Master Specialisation: Work and Organisational Psychology

Thesis Supervised by:

Alicia Walkowiak, PhD

Drs. Rosine Rutten

Assignment due date: 31.08.2024

Word count: 8.193

Abstract

The menstrual cycle is the most common recurrent biological process experienced by half the world's population, yet it has never been studied in the context of recovery. The present study examined the mediating roles of the physical and social dimensions of recovery activities between the late luteal and late follicular phases and psychological detachment. Due to the hormonal interplay of estrogen and progesterone, it was hypothesised that engagement in physical and social dimensions during the late luteal phase would inhibit psychological detachment. Conversely, it was hypothesised that engagement in physical and social dimensions during the late follicular phase would positively influence psychological detachment. A within-person daily diary design was used over 35 days. Participants ($N = 289$) had to complete a baseline questionnaire, as well as a daily questionnaire from the afternoon until midnight of the same day, in which the variables of the question were measured. Results supported only an indirect effect between late follicular phase and psychological detachment through the physical dimension of recovery activities. The results suggest that during that phase, supported by their biological rhythms at this time, individuals should prioritise activities with physical characteristics.

Keywords: menstrual cycle, late follicular phase, late luteal phase, social activities, physical activities, psychological detachment

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Is Recovery a Monthly Rollercoaster? How Menstrual Cycle Phases Affect Engagement in Recovery Activities and the Impact on Psychological Detachment.

It was only in 2023 when Spain became the first European country to approve paid sick leave for women experiencing menstrual pain. This decision could be seen as a milestone, as the latest statistics show that women consist 51,3% of the workforce in Europe[1]. However, the impact of the menstrual cycle is not limited to women alone, but has a broader influence that goes beyond the individualistic aspect (Hennegan et al., 2021). For instance, there is evidence that the menstrual cycle affects women's productivity (Ponzo et al., 2022; Schoep et al., 2019a). In particular, in a nationwide study, the authors found that the productivity lost on work, known as presenteeism, is the bigger contributor to this regard (Schoep et al., 2019a). These findings showcase how costly the impact of the menstrual cycle can potentially be for an organisation (Schultz et al., 2009). Thus, it is crucial to investigate other potential consequences of the menstrual cycle to shed light on its impacts for both individuals and organisations.

An integral part of the menstrual cycle is the recurrent fluctuation in hormones that seem to drive it, namely estrogen and progesterone (Reed & Carr, 2015). The cycle can be separated into two main phases: the follicular or proliferative phase and the luteal or secretory phase (Reed & Carr, 2015). These two phases are distinguished by ovarian activity and are separated by the event of ovulation (Blagrove et al., 2020). The follicular phase is characterised by the formation of ovarian follicles and is primarily driven by estrogen (Blagrove et al., 2020). Correspondingly, the luteal phase involves the formation of the corpus luteum, which primarily secretes progesterone to support the endometrial preparation, necessary, for the implantation of a fertilised egg (Reed & Carr, 2015). The fluctuation of hormones in its phases has been investigated in several contexts, such as the context of athletic performance (Carmichael et al., 2021), mental disorders (Handy et al., 2022), nutrition (Rogan & Black, 2023), but is relatively unexplored in the literature of organisational psychology (Grandey et al., 2020). Accordingly, the present study represents an effort to contribute towards the advancement of this field.

[1] https://ourworldindata.org/female-labor-supply

One way in which the menstrual cycle could impact women in the workforce, is through recovery, which is a highly researched topic in the field of organisational psychology. The literature recognises two important and interconnected approaches involved in recovery, that of recovery experiences and recovery activities (Sonnentag et al., 2022). The experiences refer to psychological states outside of work and include aspects of psychological detachment, relaxation, mastery and control (Sonnentag & Fritz, 2007; Sonnentag et al., 2022). On the other hand, recovery activities refer to what people do during their non-work time (Sonnentag, 2001); this can be, among others, engaging in physical activity, a hobby or being social (Sonnentag et al., 2022). Recovery activities seem to be immediate factors contributing to recovery experiences (Alameer et al., 2023). Crucially, to our present knowledge, there is no scientific publication on how the menstrual cycle connects to this relationship. Consequently, it is of primary significance to understand the role of the menstrual cycle on ensuing recovery to address the gap in the literature.

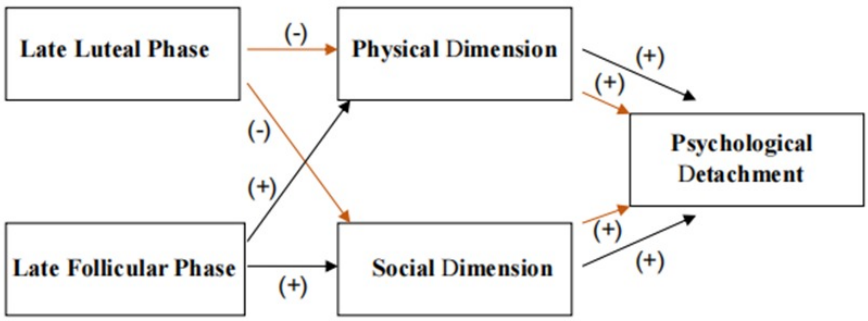
The present study, therefore, aims to shed light on how different phases of the menstrual cycle impact engagement in recovery activities and the consequences on recovery experiences. Specifically, the study will look into the late luteal and late follicular phases. The choice of these specific menstrual phases is based on the fact that research, to date, has mainly focused on the menstruation phase (Motro et al., 2019). From the recovery experiences, this thesis focuses on psychological detachment, as it is the most researched recovery experience (Sonnentag et al., 2022), with the most robust relationship with impaired well-being (Sonnentag & Fritz, 2007). That is to say, psychological detachment is a key construct in understanding well-being. Of the recovery activities, only the physical and social dimensions will be investigated; physical and social activities seem to be the most suitable for avoiding work-related thoughts (Sonnentag & Zijlstra, 2006), aligning with the core aspect of psychological detachment.

This study makes several important contributions. Firstly, the study aspires to contribute to the understanding of how biological processes, such as the menstrual cycle, can potentially assist or hamper recovery. By doing so, organisations could be equipped with knowledge to better accommodate the needs of their employees. Secondly, this study is an

attempt to bring forward discussions about the menstrual cycle, its female hormones and work. Likewise, it is a goal to cease sustaining stereotypes surrounding the cycle and normalise obtaining appropriate support to improve well-being (Grandey et al., 2020). Finally, the present study will follow a longitudinal within-person design known for its strength in demonstrating causality (Kimberly, 1976). In particular, the within-person approach, which has statistical power and reduced error variance, will contribute to a better understanding of the results and allow for a better comparison between the two sub-phases (Charness et al., 2012). In Figure 1 is depicted the proposed model.

Figure 1

The Proposed Research Model.



Note. Orange arrows represent the paths starting from the late luteal phase, and black arrows represent the paths starting from the late follicular phase.

The menstrual cycle and its physiological impact

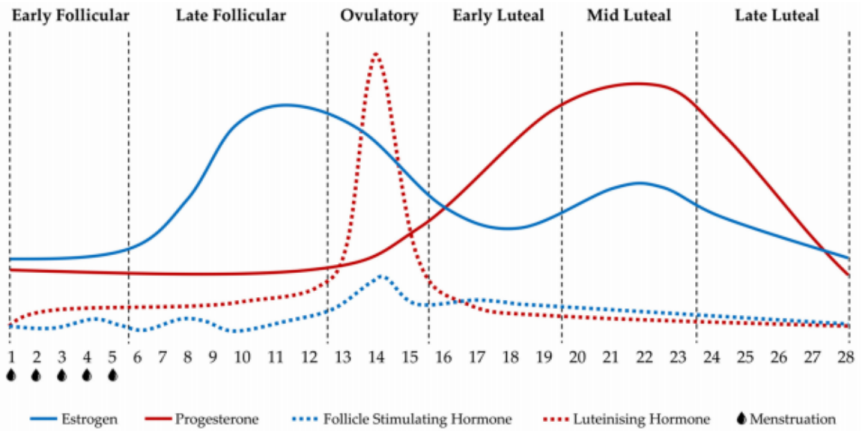
A sequence of successive processes characterises the menstrual cycle to prepare the uterus for a potential pregnancy (Carmichael et al., 2021). An eumenorrheic menstrual cycle, which occurs regularly, lasts between 21 and 35 days with an average duration of 28 days (Carmichael et al., 2021; Reed & Carr, 2015). The follicular phase is initiated from the first day of menstrual bleeding (or menses) until the day of ovulation when the mature egg is discharged, and the corpus luteum is created (Thompson & Han, 2019). This signals the beginning of the luteal phase, which ends if a pregnancy has not occurred, just before the next menstrual bleeding (Thompson & Han, 2019). However, the simplistic distinction of the menstrual cycle into two phases does not allow for a complete comprehension of how several hormones in the menstrual cycle occur (Carmichael et al., 2021). Therefore, a more detailed breakdown of the phases, such as early follicular, late follicular, ovulatory, early luteal,

mid-luteal and late luteal, is necessary (Thompson & Han, 2019).

As mentioned above, several hormones play a crucial role in the different phases. Female sex hormones, such as estrogen, progesterone, follicle-stimulating hormone (FSH), luteinising hormone (LH) and gonadotropin-releasing hormone (GnRH), fluctuate along the different phases of the menstrual cycle (Reed & Carr, 2015; Schmalenberger et al., 2021). The cycle is regulated by two of these hormones produced by the ovaries, estrogen and progesterone (Thiyagarajan et al., 2022). During the early follicular phase in the brain, the hypothalamus has increased levels of GnRH, prompting the anterior pituitary to secrete FSH and LH (Marieb & Hoehn, 2007). These hormones facilitate follicle maturation and estrogen production (Marieb & Hoehn, 2007). As estrogen levels increase during the late follicular phase, they trigger a surge of LH, leading to ovulation around day 14, known as the ovulatory phase (Reed & Carr, 2015). The corpus luteum, formed after the mature egg's release, performs as a temporary endocrine organ that prepares the endometrium for the implantation of a fertilised egg (Reed & Carr, 2015). Additionally, it secretes progesterone and estrogen during the early luteal phase, which, in abundance, inhibit further LH secretion via negative feedback, progressing through the mid and late luteal phases (Marieb & Hoehn, 2007). If fertilisation does not occur, the corpus luteum regresses, causing estrogen and progesterone levels to gradually decline before reaching a baseline, just before the beginning of a new cycle (Marieb & Hoehn, 2007; Reed & Carr, 2015). In Figure 2 a visual representation is depicted.

Figure 2

Hormonal Fluctuations During the Menstrual Cycle Phases of an Eumenerrhoic 28-day Cycle.



Note. Figure 2 is reprinted from Carmichael et al. (2021, p. 2).

These hormonal swings of the menstrual cycle are linked with menstrual cycle-related symptoms (Clayton, 2008). The symptoms can vary from physical (e.g. breast tenderness, abdominal pain, headache, back pain), behavioural (e.g. changed eating patterns) and emotional alterations (e.g. frustration, nervousness) (Clayton, 2008; Laessle et al., 1990; Matsuura et al., 2020). Even though a great proportion of the symptomatology is more evident in women with premenstrual syndrome (PMS) or a certain menstrual disorder, these are common among most menstruating women. For instance, 75-80% of women usually experience a moderate degree of symptoms (Sternfeld et al., 2002). Notably, most research focuses on women with menstrual abnormalities, but since symptoms are universal, looking into the eumenorrheic female population is also important.

Premenstrual symptoms, the ones that occur during the week before menstruation, are particularly more prominent due to low concentrations of estrogen and progesterone (Clayton, 2008; Laessle et al., 1990; Woods et al., 1982). Physical complaints about abdominal pain and breast tenderness are, in fact, significantly related to the late luteal phase (Laessle et al., 1990). Especially lower abdominal cramps, which are one of the most characteristic symptoms of the menstrual cycle, seem to cause severe discomfort (Kiesner & Pastore, 2010). Due to this discomfort, some women indicate lower social engagement (Handy et al., 2022). Additionally, a study among athletes revealed that premenstrual symptoms were conducive to fatigue and a perceived reduction in performance (Armour et al., 2020). Low concentrations of these hormones may contribute to fatigue because estrogen primarily functions as an anabolic hormone, promoting energy storage and the synthesis of complex molecules (Gault & Smith, 2023). Consequently, it could be argued that physical discomfort, fatigue and feeling less energised impose an increased need for rest.

On the contrary, the late follicular phase seems to present an opposite physiological profile. The hormonal fluctuation here is what will gradually lead to the important event of ovulation (Carmichael et al., 2021). Estrogen is the dominant hormone in this phase, where it reaches its peak level (Carmichael et al., 2021). Coupled with low levels of progesterone, it might be the reason the performance of athletes is better in that phase, and their energy levels are higher (Grandey et al., 2020). Nevertheless, in the late follicular phase, there are also

fewer physical and psychological symptoms than in the late luteal phase (Gonda et al., 2008; Manikandan et al., 2016). Therefore, it could be argued that women in the late follicular phase require less need for rest, compared to the late luteal phase.

Evidently, a relationship between the menstrual cycle and well-being exists, and estrogen is a key mechanism in this relationship (Brace & McCauley, 1997). One might consider why work and well-being; the answer rests in the fact that well-being is associated with work concepts such as productivity (Bellet et al., 2024), job performance (Judge et al., 2001), absenteeism (Kuoppala et al., 2008) and turnover (Wright & Bonett, 2007). Recent studies have suggested that the menstrual cycle is also linked to these outcomes. For instance, Herrmann and Rockoff (2013) found that menstrual symptoms account for increased illness-related absenteeism from work. Given the established links between well-being and work outcomes, it is crucial for research to focus on how late luteal and late follicular phases might affect well-being.

The concept of recovery and its core elements

Recovery from work is also a highly researched topic with which well-being is related (Sonnentag et al., 2022). Recovery can be defined as an unwinding and replenishing process in which an individual's heightened level of stress, caused by a stressor or any demand, gradually returns to its original, pre-stress level (Sonnentag et al., 2017). What, though, necessitates the need for recovery? According to the Effort-Recovery Model by Meijman and Mulder (1998), demands imposed at work or high workload lead to load reactions in the employee, such as increased cortisol levels, elevated heart rate, and a state of depleted energy levels, namely fatigue. In suboptimal circumstances, when these reactions are prolonged or recurrent after work, recovery is lacking (Geurts & Sonnentag, 2006). Consequently, the employee returns to work in a deficient state and has to exert more effort to perform appropriately at work (Geurts & Sonnentag, 2006). This cycle of insufficient recovery and compensatory effort results in accumulated fatigue, rendering the need for recovery urgent (Sonnentag & Zijlstra, 2006). In this regard, recovery experiences and recovery activities alleviate this urgent need (Sonnentag et al., 2022).

Recovery experiences, as core recovery processes, refer to the way people experience

their non-work time (Sonnentag & Fritz, 2007). The four main recovery experiences are psychological detachment (i.e. refraining from work-related thoughts), relaxation (i.e. the experience of reduced sympathetic activation), mastery (i.e. the experience of personal development) and control (i.e. a level of autonomy and choice in determining methods and actions during non-work time) (Sonnentag & Fritz, 2007; Sonnentag et al., 2022). Importantly, recovery experiences are found to positively contribute to well-being at bedtime (Sonnentag et al., 2022). Especially, psychological detachment during non-work time is associated with better mood, less negative affect and fatigue at the end of the evening and in the following morning (Sonnentag & Bayer, 2005; Sonnentag et al., 2008). Moreover, psychological detachment is very important to well-being in the long term (Gu & You, 2020; Sonnentag et al., 2010). Clearly, understanding the impact of menstrual cycle phases on psychological detachment is essential.

On the other hand, recovery activities refer to the kind of activities people engage in during their non-work time to reduce fatigue (Demerouti et al., 2009; Sonnentag, 2001). The most overlooked activities are the physical, social and low-effort. These activities are also associated positively with well-being (Rook & Zijlstra, 2020; Sonnentag, 2001; Sonnentag & Zijlstra, 2006), as they seem to be precursors of recovery experiences (Alameer et al., 2023). In particular, physical activities contribute to psychological detachment, because their demanding nature prevents the mental engagement with work-related thoughts (Feuerhahn et al., 2014). It also seems that social activities are used as a coping mechanism for some people, as they provide a distraction after working hours (Cropley & Millward, 2009). As such, physical and social activities could be the intermediating factors connecting menstrual cycle phases and psychological detachment. Given the close relationship between recovery activities and experiences, it seems useful to use the dimensional approach proposed by Alameer et al. (2023), to understand which characteristic is behind the effects on psychological detachment, since a physical activity can also be social at the same time.

The menstrual cycle phases and their connection to recovery

While physical and social activities are important for psychological detachment, as discussed above, their engagement may be influenced by physiological changes that occur

during the menstrual cycle. These changes could affect participation in these activities and consequently the ability to psychologically disengage from work. Physical activities, in this instance, require an energy expenditure, as they entail the extent to which an activity requires physical effort (Alameer et al., 2023). According to the distraction hypothesis, the improvement in mood from physical exercise is not due to its specific actions but rather the relief or break it offers from troubling thoughts and daily stress (Yeung, 1996). This hypothesis aligns with the core aspect of psychological detachment, as the mental disengagement from work-related thoughts (Sonnentag & Fritz, 2007). For example, more strenuous physical activities are more inducive to recovery because of greater psychological detachment (van Hooff et al., 2019).

Notably, women in the late luteal phase, as mentioned before, might experience fatigue and feel less energised, which could increase their need for restoration (Armour et al., 2020; Gault & Smith, 2023). Therefore, they might engage less in activities that entail a physical dimension, which also requires physical effort, and thus experience impaired psychological detachment. Conversely, women in the late follicular phase have fewer physical symptoms and report higher energy levels (Grandey et al., 2020). With this in mind, engagement in activities with a physical dimension could potentially be facilitated and contribute to improved psychological detachment. Thus, this study proposes that:

Hypothesis 1: *Engagement in recovery activities with a physical dimension mediates the relationship between the late luteal phase and psychological detachment, such that women in that phase will experience lower levels of psychological detachment.*

Hypothesis 2: *Engagement in recovery activities with a physical dimension mediates the relationship between the late follicular phase and psychological detachment, such that women in that phase will experience higher levels of psychological detachment.*

Furthermore, social activities refer to those involving interactions with other individuals (Alameer et al., 2023). These activities can include getting together with friends, family or other people (Sonnentag, 2001). The time spent with others could be the right set of circumstances to help stop thinking about work (Cropley & Millward, 2009). For instance, Ten Brummelhuis and Bakker (2012) found that social activities allow workers to

psychologically detach from work and also enhance the next morning's vigour through it. These suggest that social activities are a contributing agent to psychological detachment and subsequent well-being (Wang et al., 2018).

However, during the late luteal phase, women report reduced engagement in social interactions due to physical discomfort (Handy et al., 2022; Kiesner & Pastore, 2010). Coupled with experiencing fatigue and a sense of depleted energy, there might be a temporary withdrawal from social interactions and, hence, an adverse impact on psychological detachment. This differs from the late follicular phase, where women experience fewer symptoms and have higher energy levels (Gonda et al., 2008; Grandey et al., 2020; Manikandan et al., 2016). To that end, during the late follicular phase, a halt in social interactions is not expected, which will positively impact psychological detachment. Thus, this study proposes that:

Hypothesis 3: *Engagement in recovery activities with a social dimension mediates the relationship between the late luteal phase and psychological detachment, such that women in that phase will experience lower levels of psychological detachment.*

Hypothesis 4: *Engagement in recovery activities with a social dimension mediates the relationship between the late follicular phase and psychological detachment, such that women in that phase will experience higher levels of psychological detachment.*

Method

The purpose of this study was to assess whether the late luteal and late follicular phases of the menstrual cycle affect the engagement in the physical and social dimensions of recovery activities and the subsequent impact on psychological detachment. The study was part of a bigger project about the influence menstrual cycle phases might have on women's work-life experiences and has been approved by the local ethical review board (code: ERCPN-OZL_267_58_04_2023_S1, Faculty of Psychology and Neuroscience, Maastricht University).

Participants and design

To be eligible for participation, individuals were required to be at least 18 years old and to menstruate. Additionally, they were required to work a minimum of 20 hours per week,

to have no gynaecological issues (e.g. endometriosis, PCOS), to refrain from using any hormonal contraceptives (e.g. the birth control pill, the vaginal ring, hormonal IUD, hormonal implant or skin patch) and to be fluent in either English or Dutch. The study was conducted using two online questionnaires: an initial intake questionnaire and a daily questionnaire. A within-person perspective was adopted, and the hypotheses were examined using a 35-day daily diary design.

A total of 759 individuals consented to participate in the study and were provided with the link to complete the daily surveys. Following the data cleaning procedure, three individuals were excluded due to menopause, one due to pregnancy, and one due to the use of hormonal contraceptives. Another three people who were not certain about these were also removed, since these could alter the hormonal fluctuations observed in a natural cycle. Furthermore, 34 individuals were excluded because they worked less than 20 hours per week and did not qualify for the participation requirements. Moreover, 274 individuals were deleted, as the participants had only completed the intake survey and did not provide data for any of the daily surveys. Of the participants, 25 were eliminated because they did not provide any information about their menstruation or did not use a period tracker application from which data about their cycle could be obtained. A further 26 individuals were excluded for various reasons, including failure to indicate the initiation of their menstrual cycle or lack of accountable data from the period tracker application, for those who utilised such a tool. Additionally, 103 individuals with a menstrual cycle length exceeding 32 days were omitted from the analysis. Regarding these final two cases, the individuals were excluded, as it would not be feasible to accurately determine their menstrual cycle phases.

The final sample comprised of 289 people (99.30% women, .35% non-binary, .35% preferred not to indicate) who were fluent in English or Dutch. Their mean age was 31.50 years (*SD* = 6.16; range = 19-54), and their average working hours were 38.70 per week (*SD* = 8.25; range = 20-70). The sample was predominately Greek (79.20%), followed by Italian (6.20%), and Dutch (3.60%). The majority obtained a university degree (55% of the participants had a master's degree, 29.80% a bachelor's degree and 3.80% a PhD) and were employed in a variety of sectors, among others, in education and/or research (20.40%),

healthcare (14.90%), and business services (10.70%).

Procedure

The sample was recruited using a variety of methods, including snowball sampling, online recruitment via social media platforms, campus and city recruitment through the placement of physical posters (Maastricht, the Netherlands), and from the networks of the four master's students involved in the project. The study was conducted using an online survey platform named "Qualtrics". Participants had access to the information letter through a link or a QR code, where they were informed that participation was voluntary and did not result in any form of compensation. All participants were given additionally a general explanation of the study without providing information on specific variables or hypotheses. After reading the information letter, participants were requested to indicate their consent to take part in the study.

Those who provided consent were redirected from the information letter to complete the intake survey, which initially assessed adherence to the inclusion criteria (e.g. asking if they use hormonal contraceptives). Following, there were questions about demographics (e.g. age, gender, working sector), personality, cycle-related information (e.g. menstrual cycle symptoms) and anticipated menstrual stigma, some of which were part of the overall project. In total, the intake survey required approximately 10 minutes to complete. From the following day, participants started receiving an automated e-mail every evening around 19:00 local time, with the link to the daily survey. This was accessible only until 23:59 local time of the same day, to observe the day-to-day effects of the constructs of interest.

In the daily questionnaire, respondents would answer all questions if they indicated it was an official working day for them. If it was not, they would only answer a limited number of questions instead. The topics assessed in that questionnaire were sleep quality, positive and negative affect, concentration, fatigue, mood swings, task performance, work engagement, organisational citizenship behaviour (OCB) and counterproductive work behaviour (CWB), which were part of the larger project. This survey was distributed for a period of 35 days and ranged from one to five minutes to complete, which adheres to suggestions for diary questionnaires not to exceed five to seven minutes in duration (Reis & Gable, 2000).

Finally, participants could select their preferred language (English or Dutch) at the outset of both the intake and daily surveys. The questions and constructs presented in English were translated into Dutch by a Dutch master's student participating in the project with the assistance of generative AI (ChatGPT, from OpenAI) and subsequently verified by one of the project's responsible researchers, who also has Dutch nationality.

Measures

The measures described below are the ones that were used to examine the thesis's research question, and they were derived from both intake and daily questionnaires. The scales used to measure the constructs of interest were used in their shorter versions. This is a common practice that is used in diary studies to assist in the daily completion of the questionnaires (Ohly et al., 2010).

Menstrual cycle phases. To code the menstrual cycle phases during the analyses, a series of questions were posed to the participants in order to elicit information regarding their menstrual cycle. The intake survey included questions regarding the date of the participant's last menstruation and the level of certainty associated with this date. The date was specified in the format dd/mm/yyyy, and the level of certainty was indicated using a slider. Additionally, the survey assessed the average length of the participant's menstrual cycle over the previous six months, which was represented by a number of full days. In the daily survey, participants were required to indicate whether or not they menstruated on each day, selecting either "yes" or "no." If they responded "no," they could utilise a text box to specify the date of their first menstruation day in the event, that day, they did not complete the daily survey.

Recovery activities. Physical and social dimensions of the recovery activities were measured using the short version of the Recovery Activity Characteristics (RAC) questionnaire (Alameer et al., 2023). Example items were "Today after work, to what extent did you engage in activities that included vigorous physical activity", and "Today after work, to what extent did you engage in activities that involved communicating with others". Respondents answered these items on a 5-point Likert scale (1= *strongly disagree*; 5= *strongly agree*). Cronbach's alpha over the 35 days ranged from .769 to .981 (M = .91) for the physical characteristic and .831 to .992 (M = .91) for the social characteristic.

Psychological detachment. The construct was measured by using four items of the Recovery Experience Questionnaire (REQ) (Sonnentag & Fritz, 2007). The items were reformulated to specifically refer to the time after that day's work by adding "Today after work…". Respondents answered items such as "I didn't think about work at all" on a 5-point Likert scale (1= *strongly disagree*; 5= *strongly agree*). Cronbach's alpha for psychological detachment over the 35 days ranged from .872 to .955 (M = .91), indicating good reliabilities.

Analyses

The data were analysed with the program IBM SPSS 29 (Field, 2024) with the addition of MLMED Macro for SPSS, which simplifies the fitting of multilevel mediation (Hayes & Rockwood, 2020). Multilevel analysis was utilised for the analysis, also known as hierarchical linear modelling (Raudenbush, 2002). With respect to the present study, multilevel analysis considers the dependence of the data at the daily level within each individual. The dataset had a 2-level hierarchical structure, with the daily measurements of the variables (level 1) nested within the participants (level 2). Only the mediators, physical and social dimensions, could be person-mean centred to interpret exclusively the within-person effects (Ohly et al., 2010), since the menstrual cycle phases are binary variables. Finally, the number of 289 participants qualifies for solid effects in a diary study (Ohly et al., 2010).

The menstrual cycle phases were coded using the information obtained from the two questionnaires. A new variable was computed based on the question inquiring whether the day they completed the daily questionnaire marked the onset of their menstrual cycle. Accordingly, the days of the cycle were scaled starting with one (1) as the first menstruation day and continuing until the end of the 35 days for each participant, in case a second menstruation did not occur. The days preceding the new menstruation were scaled based on a calculation of the previous cycle initiation, as reported in the intake survey, and the day the daily survey was completed. These were also verified by data from the participants' cycle tracker application, where available, and the number of days was checked to ensure alignment with the participants' average cycle length. Considering that the average menstrual cycle lasts 28 days, and ovulation occurs around day 14 (Reed & Carr, 2015), days 7-13 were classified as the late follicular phase, and days 24-32 were classified as the late luteal phase.

Results

Table 1 presents the means, standard deviations (SD), Cronbach's alphas (α) and the zero-order correlations of the study variables. The correlations reflect the relationships between the variables at the day level across all days. Thus, the nested data structure is not considered. Since the study would examine the within-person variation, the intraclass correlation coefficient (ICC) was calculated by computing a null model (Model 1) to justify the multilevel modelling. By doing so, it was found how much of the variance of the dependent variable was attributed to the between-person level and if there was a sufficient remaining percentage to be explained at the within-person level. The ICC for psychological detachment was .43, which means that 43% of the variance in psychological detachment is explained by the differences between people. The remaining percentage indicated that 57% of the variance was attributed to within-person differences, which validated the use of multilevel analysis since respondents differed more about their usual psychological detachment rather than from each other.

Table 1
Chronbach's alpha, Descriptive Statistics and Zero-order Correlations.

Variable	α	M	SD	1	2	3	4	5	6
1. Late Luteal Phase									
2. Late Follicular Phase									
3. Age		31.50	6.16				.09	-.08	.03
4. Physical Dimension	.769-.981	2.53	.80			.09		.28**	.11
5. Social Dimension	.831-.992	3.34	.79			-.08	.28**		-.06
6. Psychological Detachment	.872-.955	3.32	.76			.03	.11	-.06	

Note. Cronbach's alphas (α) represent a range over the 35 days. Correlations below the diagonal are Between-persons correlations and Within-persons correlations are above.
M = Mean; SD = Standard Deviation; *p < .05; **p < .01; ***p<.001

Before proceeding with the hypotheses testing, which for this thesis was a multilevel mediation analysis, the predictors and dependent variable were modelled to examine their relationships (Table 2). The predictors of the late follicular and late luteal phases were added in separate models that allowed for a variation in intercepts but had a fixed slope (Model 2). The model fit did not improve compared to the null model when adding the predictors of either the late follicular phase ($\chi^2(1) = .33, p > .05$) either the late luteal phase

($\chi^2(1) = .23, p > .05$) and comparing the 2-log likelihood ratio. Within individuals, the substantial remaining variance (50%) in psychological detachment was explained, but this was likely due to the nested structure of data rather than the late follicular or late luteal phases since none of the two significantly predicted psychological detachment (Snijders & Bosker, 2011).

Despite these results, a third source of variance was added, which let both intercepts and slopes to vary (Model 3), in case there were obscured effects. For the late follicular phase as predictor, the log-likelihood ratio of the random intercept-fixed slope model was compared to the one with the random slope and suggested that the more complex model represents the data better ($\chi^2(2) = 6.95,\ p < .05$). However, the late follicular phase still did not significantly predict psychological detachment, which is consistent with the previous model. Conversely, for the late luteal phase, the model did not improve the fit of the data ($\chi^2(2) = 1.37, p > .05$), and the phase did not significantly predict psychological detachment either. It is though important to note, that in fact, the model fit for the late luteal phase with a varying slope is uncertain because the model failed to converge. Thus, results should be interpreted with caution.

Hypotheses testing

MLMED macro was added to SPSS to test the four mediation hypotheses that sought to examine how late luteal and late follicular phases relate to psychological detachment through physical and social recovery activities' dimensions (Table 3). For the estimation of significance of the indirect effects (Table 4), the Monte Carlo method with 95% confidence intervals was used. This procedure allowed for precision due to a smoother distribution of the data in the complex indirect effects (Preacher & Selig, 2012).

Hypothesis 1 proposed that engagement in recovery activities with a physical dimension mediates the late luteal phase and psychological detachment, such that women in that phase would experience lower levels of psychological detachment. However, the late luteal phase was not related to psychological detachment through the physical dimension ($\gamma = -.00; CI[-.01, .00]$); thus, Hypothesis 1 was not supported. A close inspection of the different paths in Table 3 shows that the missing indirect effect was due to a missing

significant link between the late luteal phase and the physical dimension since the relationship between the physical dimension and psychological detachment was statistically significant.

Concerning Hypothesis 2, which recommended a mediation of the physical dimension between the late follicular phase and psychological detachment, such that women in that phase would experience higher levels of psychological detachment, a significant indirect effect was found ($\gamma = .01$; $CI[.00, .02]$); thus, Hypothesis 2 was supported. However, it is important to note that significance based on the p-value ($p = .055$) would only indicate a trend towards mediation with a value so close to the threshold for statistical significance. That is the reason Monte Carlo confidence intervals are more robust for complex data as the nested ones. Additionally, the separate path from the late follicular phase to the physical dimension is positive and statistically significant, as is the path from the physical dimension to psychological detachment. Since the direct effect of the phase to psychological detachment is not significant, the indirect effect suggests a full mediation.

Hypothesis 3 suggested that engagement in recovery activities with a social dimension would mediate the relationship of the late luteal phase and psychological detachment, such that women in that phase would experience lower levels of psychological detachment. Indirect effects via the social dimension of recovery activities were not found ($\gamma = -.00$; $CI[-.01, .01]$). Therefore, Hypothesis 3 was not supported. In that case, the link between the late luteal phase and the social dimension, albeit negative, is not significant. At the same time, the relationship between the social dimension and psychological detachment is positive and significant, which explains the missing indirect link.

Finally, Hypothesis 4 proposed that engagement in activities with a social dimension would mediate the relationship between the late follicular phase and psychological detachment, such that women in that phase will experience higher levels of psychological detachment. For the late follicular phase and psychological detachment, the social dimension did not mediate the relationship ($\gamma = -.00$; $CI[-.01, .01]$), rejecting also Hypothesis 4. Looking into the separate paths, it is revealed that once more, there is a missing relationship between the late follicular phase and the social dimension, which contrasts the positive and highly significant path of the social dimension and psychological detachment.

Table 2
Results of Multilevel Analysis.

	MODEL														
	Null (Model 1)			Random Intercept Fixed Slope (Model 2)						Random Intercept Random Slope (Model 3)					
DV	Psychological Detachment			Psychological Detachment			Psychological Detachment			Psychological Detachment			Psychological Detachment		
Parameters	γ	SE	t	γ	SE	t	γ	SE	t	γ	SE	t	γ	SE	t
Within level															
Intercept	3.34***	.04	76.42	3.35***	.04	74.96	3.35***	.04	75.27	3.35***	.04	74.07	3.35***	.04	76.47
Late Follicular Phase				-.02	.04	-.57				-.03	.05	-.65			
Late Luteal Phase							-.02	.05	-.48				-.02	.05	-.52
Variance Components															
Within-person Variance	.50***	.02		.50***	.02		.50***	.02		.48***	.02		.50***	.02	
Intercept Variance	.38***	.04		.38***	.04		.38***	.04		.39***	.05		.36***	.04	
Slope Variance										.08*	.04		.00§	.00	
Intercept Slope co-variance										-.04	.03		.04	.03	
Additional Information															
ICC	.43														
-2*LL	4639.57			4639.24			4639.34			4632.30			4637.97		
Number of estimated parameters	3			4			4			6			6		
Δ-2**LL	-			.33			.23			6.95			1.37		
Δ df	-			1			1			2			2		

Note. γ = estimate; SE = Standard Error; ICC = Intraclass Correlation Coefficient; -2*LL = -2 Log Likelihood; Δ = Difference; df = estimated parameters.
§ = This covariance parameter is redundant, the test statistic and confidence interval cannot be computed.
*p< 0.05. **p< 0.01. ***p< 0.001

Table 3
Multilevel Path Analysis Results at the Within-Person Level.

Variable	1-1-1 Mediation Model				1-1-1 Mediation Model			
	Physical Dimension		Psychological Detachment		Social Dimension		Psychological Detachment	
	γ	SE	γ	SE	γ	SE	γ	SE
Within level								
Intercept$_{LF}$	2.50***	.08	3.06***	.16	3.29***	.08	3.53***	.21
Intercept$_{LL}$	2.56***	.06	3.05***	.16	3.37***	.06	3.52***	.21
Late Follicular Phase	.17**	.06	-.03	.04	-.01	.06	-.02	.04
Late Luteal Phase	-.07	.07	-.03	.05	-.03	.07	-.03	.05
Physical Dimension			.04**	.02				
Social Dimension							.07***	.02
Residual Variance$_{LF}$	1.02***	.03	.50***	.02	1.01***	.03	.49***	.02
Residual Variance$_{LL}$	1.02***	.03	.50***	.02	1.01***	.03	.49***	.02

Note. The table represents only fixed effects at the Within-person level n = 1964.
γ = estimate; SE = Standard Error; LF = Late Follicular; LL = Late Luteal.
* p < .05. ** p < .01. *** p < .001.

Table 4
Within-Person Indirect Effects with Monte Carlo Confidence Intervals.

Pathway		Monte Carlo 95% CI	
	γ	LL	UL
Late Luteal Phase → Physical Dimension → Psychological Detachment	-.00	-.01	.00
Late Follicular Phase → Physical Dimension → Psychological Detachment	.01	.00	.02
Late Luteal Phase → Social Dimension → Psychological Detachment	-.00	-.01	.01
Late Follicular Phase → Social Dimension → Psychological Detachment	-.00	-.01	.01

Note. γ = estimate; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit.
Significant at α = .05 level based on Monte Carlo 95% CI.

Discussion

The objective of this study was to investigate whether engagement in recovery activities with physical and social dimensions mediated the relationships between late luteal and late follicular phases with psychological detachment. The field of organisational psychology has long investigated the relationship between recovery activities and recovery experiences, such as psychological detachment (Sonnentag et al., 2022), but the connection of the menstrual cycle to that relationship remains largely unexplored. To contribute to the field and understand the menstrual cycle's impact, a 35-day diary design was employed, and data

attained were analysed at the within-person level to infer causality (Kimberly, 1976). Results did not support the majority of the hypotheses, except for the mediation of the physical dimension between the late follicular phase and psychological detachment.

Discussion of results

Firstly, looking at the results of the late luteal phase, the first hypothesis was rejected. Thus, engaging in recovery activities with a physical dimension, with the latter found to positively affect psychological detachment, transcends being in that phase. Even though a negative estimate of the late luteal phase would indicate the expected outcome with respect to engagement in these activities, the result was not statistically significant. The same holds true for the third hypothesis, which suggested that during the late luteal phase, engagement in activities with a social dimension would have an adverse impact on psychological detachment. Similarly, the path of the late luteal phase to the social dimension was negative but not statistically significant.

The non-significant paths could be explained by methodological reasons for calculating the late luteal phase. According to Schmalenberger et al. (2021) when calculating the whole late luteal phase, days one to seven before the first menstruation day (i.e. calculating backwards), would be included. This approach lacks a hormonal consistency because the first half of the phase has higher estrogen and progesterone levels, which rapidly decline during the second half. The present study based the coding of the phases on an average 28-day cycle. However, the study included participants with a cycle of more than 28 days, and the late luteal phase was classified as days 24-32. Besides that, this computation included nine days for the late luteal phase for women with a longer cycle; there might be a chance that, in some cases, that calculation included a part of the mid-luteal phase. By doing so, the elevated ovarian hormones in the first half could potentially contaminate or mask the results and be the reason why the links did not appear significant, neither in the negative nor in the positive direction.

Conversely, Hypothesis 2 was supported, indicating that women in the late follicular phase engage in activities with a physical dimension, which favours psychological detachment. This phase of the cycle is predominately driven by high levels of estrogen and repressed levels of progesterone (Oosthuyse & Bosch, 2010), representing a homogeneous

hormonal profile compared to the late luteal phase. These hormones, besides their reproductive role, are also involved in physiological systems that are associated with exercise performance (Pallavi et al., 2017). Estrogen, for example, helps the body's ability to use carbohydrates and fats for energy, which improves female's energy levels and performance (Oosthuyse & Bosch, 2010). Concurrently, the low levels of progesterone, which operates in opposition to estrogen, might allow estrogen to entirely unfold its function. Therefore, the enhanced energy storage driven by the hormonal profile of the late follicular phase, could facilitate and account for the engagement in activities with a physical dimension.

Additionally, estrogen enhances serotonin transmissions (Amin et al., 2005). Low levels of serotonin have been associated with reduced energy and fatigue (Stahl, 2002). For instance, Kikuchi et al. (2010) found a link between the perception of tension-anxiety and fatigue in the late luteal phase because of low serotonin levels and suggested that the low levels of estrogen are the underlying reason. Considering that estrogens are at their highest level during the late follicular phase, serotonin levels may also report higher levels and thus reduced fatigue. Taken together, higher energy and reduced fatigue could possibly explain why this hypothesis was supported. The direct physiological link between these hormones and physical exercise facilitates the identification of the relationship between this phase of the menstrual cycle and engagement in the physical dimension.

For the fourth and final hypothesis, it was suggested that women in the late follicular phase would engage in activities with a social dimension, which would benefit psychological detachment. Interestingly, the hypothesis was not supported since the link from the phase to the social dimension was not significant. One potential explanation for the absence of a relationship, could be that the physiological impact of the hormones likely has more obscured effects compared to the physical dimension, due to the different nature of activities. Another reason could be methodological, for example participants might have answered that they engaged in social interactions after work having in mind a more casual form of interaction, such as greeting somebody outside. The items measuring the social dimension were not particularly specific, which could account for a personal interpretation of the item in question.

It is important to mention, though, that both the physical and social dimensions were

positively and statistically related to psychological detachment. The result for the physical dimension comes in contradiction with the findings of Alameer et al. (2023) who did not find statistical significance for that relationship. However, the result for the social dimension was in line with findings from the same study. For both dimensions, results are in accordance with previous research of the categorical approach for recovery activities. For example, physical and social activities are found to enhance the next morning's vigour through psychological detachment (Ten Brummelhuis & Bakker, 2012). Similarly, Feuerhahn et al. (2014) found that physical exercise after work is related to the next morning's positive effect via psychological detachment. The significant links found in this study emphasise, in line with previous research, the importance of these activities for recovery.

Nevertheless, the Effort-Recovery Model (Meijman & Mulder, 1998) could assist in understanding the results. According to the model, recovery occurs when the demands drawn on psychophysiological systems from work cease. Accordingly, recovery activities and recovery experiences help to regulate the daily need for recovery after work, offering an adequate suspension. The positive and significant relationships between the dimensions and psychological detachment are in line with the model. When people engage in the social and physical dimensions of recovery activities, regardless the menstrual phase, they get redirected from the stressful conditions imposed at work to leisure time activities that do not draw upon the same psychological and physiological resources (Demerouti et al., 2009; Sonnentag, 2001). That provides the opportunity of a clear break, to recover and allow individuals to return at work the next day in optimal condition.

The model could also be relevant for understanding the recovery process during the late follicular phase, at least for activities with a physical dimension. The significant relationship could be interpreted as an instance where the recovery process is particularly effective due to the phase-specific energy levels discussed above, which facilitates better engagement in the physical dimension, thereby helping individuals to cope with work demands. However, it is important to be cautious when interpreting insignificant results within this framework. The insignificant relationship observed between the social dimension during this phase and the absence of relationships during the late luteal phase suggests that the model

may not fully capture the complexity of these interactions. Attempting to use the model to explain insignificant findings could be misleading, implying a relationship where none exists. So, while the model offers valuable insights, it is important to recognise its limitations in explaining every aspect of how menstrual cycle phases interact with engagement in recovery activities.

Practical implications

Considering that this study only found limited effects related to the menstrual cycle, practical considerations for organisations and individuals can only be drawn out based on the connecting role of the physical dimension of activities for the late follicular phase and psychological detachment. Some useful implications could also be suggested based on the consistent benefit of physical and social dimensions of activities for detachment beyond the different phases.

Organisations could consider implementing flexible work arrangements (FWA). By doing so, they leave the control on their female employees to assist their work based on their cycle. Since there is a relationship between the late follicular phase and psychological detachment through the physical dimension, having more time to engage in such activities would help towards that direction. In those terms, women, knowing that the physical exercise would help them with their recovery, could use the FWA to prioritise physical exercise during that phase. Importantly, this initiative would be in line with Grandey et al. (2020), proposing that the cycle should not be stigmatised, and women should be able to ask for support for their health and well-being.

Looking only at the positive effects of the physical and social dimensions of activities to psychological detachment, organisations should apply policies that do not interfere with the ability to recover. These segmentation standards, in line with meta-analytic studies (Karabinski et al., 2021; Steed et al., 2021), should not allow work to continue beyond the work shift and should also include a prohibition on the use of work-related technology (i.e. checking emails) after work is done, to promote a more meaningful time away. In such cases, individuals could exploit the opportunity and prioritise engaging in activities that entail a social or a physical characteristic. Alternatively, they could also engage in activities with both

dimensions, instead of choosing only one, as proposed by Alameer et al. (2023) to experience maximum psychological detachment.

Limitations

There are some methodological problems with the study that should be mentioned to avoid misinterpretation of the results. First, and most importantly, ovulation tests were not used. This means that it was not possible to know if and when the participants ovulated. The luteal phase is generally thought to last around 14 days, starting immediately after ovulation, and the follicular phase is thought to be more variable, lasting between 10 and 16 days (Reed & Carr, 2015). However, this has recently been found to be inaccurate, with both phases showing variance (Bull et al., 2019). Because there were participants with cycles that differed from the average 28-day cycle, ovulation did not necessarily occur on day 14, so the actual size of their luteal or follicular phase could not be known. This means that hypothesised hormonal effects could actually be present at a different time. The backwards counting used in the study is the next best method of predicting sub-phases, but it is still less accurate than an ovulation test (Schmalenberger et al., 2021), and the study only followed one cycle, which may not be enough to detect patterns. Most importantly, without experimental manipulation of the actual effects of hormones, the results can only be indicative rather than causal.

In addition, the intake questionnaire only asked about the average number of hours worked per week. In this study, the questions of interest were measures that should be reflected after work. This means that there could be participants who did not have a regular morning shift. It could be that some of the participants worked in the afternoon, which would mean that when they answered the question about activities, they did not have time to do any of them. Alternatively, if the study was open from 19:00 to 23:59 local time on the same day, some people may have answered the questionnaire first and then engaged in a particular type of activity. Future studies may choose to control the work shift and only recruit people with similar working hours to ensure consistency and reliability of the results, or reduce the time available for responding to the hours before going to bed.

Moreover, this study did not control for other variables that might affect the results. For example, Alameer et al. (2023) found that people with a high need for affiliation and

extraversion seek out more social activities. This points to the complexity of studying the menstrual cycle, as it is not enough to look at the phase without taking individual characteristics into account. There may be people who are not extraverted, so they would not choose a social activity in their free time after work. Future research should also take personality traits into account when studying the menstrual cycle and recovery or examine a wider variety of recovery activities.

Finally, it should not be assumed that all women experience their menstrual cycle in the same way. The menstrual cycle is rather a complex biological procedure, that might result to varying experiences among individuals. While for some women menstrual symptoms can result in daily activities suspension (Schoep et al., 2019b) others might find adaptive strategies. For instance, in a study they found that participants did not necessarily avoid physical exercise during the phase of menstruation; instead, they adapted by choosing activities based on the severity of their symptoms (Kolić et al., 2021). The participants' ability to modify their activities based on their symptoms could mask any potential impact of the menstrual cycle phase, in question, on engagement in recovery activities. In light of this diversity, future research could examine whether and how participants adapt to their menstrual cycles, as these adaptations may influence their behaviour.

Conclusion

In conclusion, this was the first study to investigate the relationship between the menstrual cycle and recovery. The results provide evidence for a relationship between the late follicular phase and psychological detachment, through the engagement in the physical dimension of recovery activities. The hypothesised relationships involving the late luteal phase were not supported, along with the non-significant path of the late follicular phase with the social dimension. The findings nonetheless contribute to our understanding of recovery for the newly introduced dimensional approach beyond the menstrual cycle. It is important to note that these results should be interpreted as correlational rather than causal, due to the hormonal complexity of the menstrual cycle. Implications to create more inclusive and considerate workplaces can be drawn from this study, and future research should aim to build on this initial findings to further eludicate the influences of the menstrual cycle in the work context.

Disclosure of the use of Generative AI in the writing process

During the preparation of this work, I, Ermioni Styliani Vosnaki, used DeepL, in order to clarify sentences and Grammarly in order to adhere to grammatical clarity. After using these tools/services, I reviewed and edited the content as needed and I take full responsibility for the content of the publication.

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Appendix A

Information Letter

The menstrual cycle and work well-being Faculty of Psychology and Neuroscience ERCPN-OZL_267_58_04_2023_S1.

Purpose: This study investigates the influence the menstrual cycle phases may have on women's experiences at their work. Despite the cycle being the most frequent physiological occurrence experienced by the female working population, very little research has been done on this topic. Thus, your participation is extremely valuable to shed light on what menstruating women need at work.

Participant selection: We are looking for healthy menstruating women that are at least 18 years old, do not use any type of hormonal contraceptive, who are employed for at least 20 hours per week, and are proficient in English or Dutch.

Voluntary participation and time to decide: Participation in this study is voluntary and you are free to opt-out any time you wish, without explanation. There are no risks or discomforts associated with participation in this study.

Procedure: As a participant, you will be asked to complete an intake survey, in which you will answer questions about you and your work in general. This will take approximately 10 minutes. Next, you will be asked to complete a daily online survey over the time course of about 35 days. In these surveys we will assess your well-being and work experiences of that day. Completion time of each daily survey is around 1 minute on non-workdays, or 3-5 minutes on workdays. At the end of the study, we will ask you to complete one last small survey that only takes a minute. For the overall quality and success of the study, it is important that you complete as many surveys as you can. After completing the intake survey, you will receive an e-mail notification containing the daily survey link every evening around 19.00. Please check your e-mail regularly. The survey will be accessible until the end of the day (23.59). An automatic reminder will be sent to you once in case you did not complete the survey. If you forget to complete a survey, you do not have to quit participation altogether; just try to complete the next surveys.

Risks and Discomforts: There are no risks and discomforts associated with this study.

Benefits: There are no direct benefits or rewards for participating in this study.

Privacy: No Personal Data will be stored. Research Data can be published and re-used in other research, but only in such a way that they cannot be traced back to you. This concerns the following data: Demographic characteristics (e.g.: age, gender, nationality, education), Health-related data, Life-style information (exercise), Personality traits.

Contact details: For further questions or additional information about the study, you can contact the research team of master thesis students Denise Ferretti, Despoina Grimani, Hiske Haenen and Ermioni Vosnaki via fpn-workcycle@maastrichtuniversity.nl. Alternatively, you can contact the responsible researchers Alicia Walkowiak alicia.walkowiak@maastrichtuniversity.nl or Rosine Rutten rosine.rutten@maastrichtuniversity.nl

Appendix B

Material for Advertising the Study

Figure B1

The Poster of the Study for Recruiting Participants.