Journal of Adolescence 49 (2016) 81–90

Contents lists available at ScienceDirect

Journal of Adolescence

journal homepage: www.elsevier.com/locate/jado

# The impact of menstrual cycle-related physical symptoms on daily activities and psychological wellness among adolescent girls

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ARTICLE INFO

*Article history:*
Available online 24 March 2016

*Keywords:*
Menstrual and premenstrual
Symptoms
Psychological
Physical
Adolescence
Daily activities

ABSTRACT

Associations between perimenstrual physical and psychological symptoms have not been adequately studied among adolescent girls. The purpose of the present study was to test a mediation hypothesis postulating that perimenstrual disengagement from daily activities would mediate the association between physical symptoms and psychological symptoms. A non-clinical sample of $N = 208$ Italian adolescent girls (age $M = 16.68$ years) completed a 95-item online retrospective questionnaire regarding perimenstrual symptoms, and how these symptoms affect their daily activities. Structural Equation Modeling was used to test the mediation hypothesis. Results showed that physical and psychological symptoms were strongly associated. More importantly, results supported the hypothesis that perimenstrual disengagement from daily activities mediates the association between physical symptoms and psychological symptoms, but only for depressed mood and cognitive symptoms. This study provides support for a novel theoretical framework linking diverse aspects of menstrual cycle change. Longitudinal research is needed to replicate these findings.



Recurring symptoms of the menstrual cycle have been shown to be a significant source of recurring stress among adolescent girls (Cleckner-Smith, Doughty, & Grossman, 1998; Derman, Kanbur, Tokur, & Kutlut, 2004; Fisher, Trieller, & Napolitano, 1989; Vichnin, Freeman, Lin, Hillman, & Bui, 2006). For example, Fisher et al. (1989) and Cleckner-Smith et al. (1998) found that 43% and 56% (respectively) of adolescent girls had at least one extreme symptom; Vichnin et al. (2006) found that 31% met criteria for premenstrual syndrome (PMS); and Derman et al. (2004) found that 13.4% showed symptoms consistent with severe PMS. Moreover, menstrual cycle-related symptoms have also been reported across diverse national and ethnic samples. For example, with a cross-national sample from the U.S., Canada, and Slovakia, 8.3% of the adolescent girls had symptoms consistent with a diagnosis of Premenstrual Dysphoric Disorder (PMDD), and 21.3% had symptoms consistent with severe PMS (Steiner et al., 2011); and with a sample of primarily African American girls, 84.3% self-reported PMS, although stringent diagnostic criteria were not applied (Houston, Abraham, Huang, & D'Angelo, 2006). Finally, research also suggests that these symptoms are unlikely to resolve after adolescence (Borenstein, Chiou, Dean, Wong, &

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http://dx.doi.org/10.1016/j.adolescence.2016.03.007
0140-1971/

Wade, 2005; Borenstein et al., 2003). Surprisingly, most research on affective changes among adolescent girls does not consider the important question of whether and how menstrual cycle-related symptoms may interfere with the developmental course of girls who experience these symptoms.

Although much attention has focused on the psychological symptoms of the menstrual cycle, research has demonstrated that physical symptoms are also common and severe, a finding that has been validated across multiple cultures, including Japan (Takeda, Tasaka, Sakata, & Murata, 2006), Italy (Kiesner, 2009; Kiesner & Pastore, 2010; Monagle et al., 1993), and the U.S. (Laessle, Tuschl, Schweiger, & Pirke, 1990; Sternfeld, Swindle, Chawla, Long, & Kennedy, 2002; Woods, Most, & Dery, 1982). For example, Woods et al. (1982) found that 30% of U.S. women reported mild or moderate menstrual cycle-related physical symptoms like headache, skin disorders, cramps, backache, fatigue, painful breasts, and swelling, with 17% reporting menstrual cramps as severe or disabling; and Takeda et al. (2006) found that only 18.8% of Japanese women never experienced physical symptoms, whereas 34.2% rated their physical symptoms as moderate to severe. Moreover, past research has shown robust associations between physical and psychological symptoms of the menstrual cycle among adults (Kiesner, 2009; Kiesner & Pastore, 2010), and adolescents (Beal et al., 2014; Dorn et al., 2009; Negriff, Dorn, Hillman, & Huang, 2009; Raja, Feehan, Stanton, & McGee, 1992), although the cause of this association is not understood. Therefore, the aim of the present study is to better understand the associations between these symptom types within a theoretical framework that is especially relevant to this developmental age period.

## Perimenstrual symptoms, changes in daily activities, and adolescent adjustment

Physical distress has been shown to interfere with important aspects of youth's social-development. For instance, research has shown that chronic or recurrent pain in children, caused by various clinical problems (e.g., migraine headaches, abdominal pain, musculoskeletal pain, and pediatric chronic diseases), influences important aspects of family life, social life, and school functioning (for a review, see Palermo, 2000). Similarly, there is evidence that menstrual cycle-related symptoms (primarily physical) lead to difficulties in and disengagement from school, social relations, and physical activities. For example, research has shown that painful menstruation (i.e., dysmenorrhea) and other menstrual cycle-related physical symptoms are often associated with school absenteeism and impaired school performance (Banikarim, Chacko, & Kelder, 2000; Hillen, Grbavac, Johnston, Straton, & Keogh, 1999; Houston et al., 2006; Klein & Litt, 1981; Steiner et al., 2011; Vichnin et al., 2006). Specifically, Hillen et al. (1999) found that 36% of their sample of Australian adolescents experienced limitations in school because of dysmenorrhea; Klein and Litt (1981) found that 14% of their sample of U.S. adolescents missed school because of menstrual cramps; and Banikarim et al. (2000) found that 18% of their sample of American-Hispanic adolescents reported school absence resulting from dysmenorrhea. Moreover, some adolescent girls limit their time with peers (Banikarim et al., 2000), and have difficulties in social activities and relationships (Hillen et al., 1999; Steiner et al., 2011; Vichnin et al., 2006), because of perimenstrual symptoms such as dysmenorrhea (see also DSM-IV criteria for PMDD; American Psychiatric Association, 1994). For example, Hillen et al. (1999) found that 36% of their sample experienced limitations in their social activities because of dysmenorrhea, and Banikarim et al. (2000) found that 20% of their sample went out less with their friends because of perimenstrual symptoms. Finally, research has repeatedly shown that, among adolescent girls, painful menstrual cycle-related symptoms result in decreased engagement in physical activities and sports (Banikarim et al., 2000; Hillen et al., 1999; Houston et al., 2006). For example, Hillen et al. (1999) found that 38% of their sample experienced limitations in participating in sports, and Banikarim et al. (2000) found that 17% of their sample reported limiting their engagement in sports, because of perimenstrual symptoms.

Given the above evidence it is clear that perimenstrual symptoms are associated with disengagement from daily activities across multiple domains. Although the presumption is that physical pain and discomfort are the most likely cause of behavioral disengagement, these behavioral changes could also be the result of social embarrassment for such symptoms as acne and weight gain. Although these different causes are important at a theoretical level, the present study does not test for these causal mechanisms, but rather examines the potential outcomes of the observed disengagement.

Overall, decreases in school participation, social engagement, and physical activity all point to changes in daily activities as a potentially important factor linking perimenstrual symptoms with individual adjustment during adolescence. Similar to past research, the present study will also focus on physical symptoms as a predictor of changes in daily activities. Thus, it is hypothesized that physical symptoms will lead to changes in daily activities which will then lead to negative psychological outcomes. That is to say, disengagement from these activities, because of perimenstrual physical symptoms, will have a psychological cost for the individual. For example, missing out on daily activities such as school, socializing with friends, and playing sports, may result in frustration and disappointment, leading to depressed mood and intensified mood swings. Disengagement from daily activities, especially physical activities, may also have negative effects on cognitive functioning such as concentration (see Taras, 2005 for a review on physical activity and academic performance).

Physical symptoms are hypothesized to influence psychological symptoms both directly and indirectly. The direct effects may be associated with what has been referred to as a *physical distress hypothesis* (Kiesner, 2009; Kiesner & Martin, 2013), in which increasing levels of physical pain and discomfort lead directly to increased levels of psychological distress, such as anxiety, depression, and cognitive focus, without necessary changes in daily life or social relations. Evidence for this theory is inconsistent (see Kiesner & Pastore, 2010), suggesting that other mechanisms are likely involved, such as indirect effects of physical symptoms leading to lower levels of engagement in school, sports, and social activities, that then leads to affective symptoms. Research has in fact shown that low levels of school engagement (Fröjd et al., 2008; Li & Lerner, 2011), sports

engagement (Dishman et al., 2006; Motl, Birnbaum, Kubik, & Dishman, 2004), and successful peer relations (Kiesner, Poulin, & Nicotra, 2003; La Greca & Harrison, 2005), are all related to affective symptoms during adolescence, and thus challenges to successful engagement in these activities may result in risk for affective symptoms. In the present study, physical symptoms of the menstrual cycle are viewed as potential challenges to engagement in these activities and accordingly potential risk factors for affective symptoms.

Therefore, in the present study we test the hypothesis that a composite score of six physical symptoms (i.e., breast changes, back and joint pain, gastrointestinal problems, lower abdominal cramps, skin changes, and headaches) will be associated with changes in daily activities, and that changes in these activities will be associated with three psychological symptoms (i.e., depressed mood, cognitive symptoms, and mood swings). This hypothesis is tested using a retrospective computer-based questionnaire with a sample of regularly menstruating Italian adolescent girls. It should be noted that, because the data are cross-sectional, causal relations cannot be inferred. Therefore, conclusions on the proposed directionality need to be considered with caution, as bidirectional effects are possible. To help test the directionality of effects we also conduct a "reverse" mediation analysis.

Given the associations already established in the literature between physical symptoms and psychological symptoms (Kiesner & Pastore, 2010; Negriff et al., 2009), between physical symptoms and changes in daily activities (e.g., Banikarim et al., 2000; Hillen et al., 1999; Steiner et al., 2011), and between low levels of engagement and affective symptoms (Dishman et al., 2006; Fröjd et al., 2008; Kiesner et al., 2003; La Greca & Harrison, 2005; Li & Lerner, 2011; Motl et al., 2004), the hypothesized associations within the present model are empirically supported.

## Method

### *Participants*

Participants included in the present analyses were 208 Italian adolescent girls (from a non-clinical sample of $N = 259$, see below for exclusion criteria) with a mean age of $M = 16.68$ years ($SD = 1.45$, range: 15–19). Most participants identified themselves as being Italian (98%). The average age of menarche was $M = 12.43$ years ($SD = 1.13$), and the average menstrual cycle was $M = 30.30$ days ($SD = 5.72$).

Post-menarcheal adolescent girls in the first, second, fourth, and fifth years of one high school in the north of Italy, who had a regular menstrual cycle, were asked to participate. Girls with and without menstrual difficulties were encouraged to participate, as well as individuals who were using hormonal contraceptives or therapy (although these individuals were excluded for the following analyses). Data were collected during the months of February through May. Participation was voluntary and did not lead to any compensation. The study and procedure was reviewed and approved by the Ethics Committee of Psychological Research, of the University of Padova.

Initial recruitment was done in class during normal hours. After excusing all male students, the girls were given a brief explanation of the study by two research assistants. It was explained that the privacy of the girls would be guaranteed (e.g., no list of names was maintained), and that the data would be accessible only to researchers (not to teachers, parents or friends). Finally, practical information about data collection, as well as general information about the menstrual cycle and related terms, was provided. A passive consent procedure was used in which an information letter for the parents was sent home with all potential participants, and parents were asked to sign and send back the letter if they did *not* want their daughter to participate in the study. Moreover, the adolescents themselves had the opportunity to assent or decline participation. No parents returned the letter.

For the present analyses, participants were excluded for any one of the following three reasons: using the birth-control pill, being older than 19, or having an irregular cycle. Pill-users ($n = 29$) were excluded because (1) the birth-control pill may affect perimenstrual symptoms (both negatively and positively), and (2) different pills have different hormonal combinations with different effects, making it difficult to combine them into one meaningful group of "pill-users". Twelve participants were older than 19 (four of whom were also pill users) and were excluded in order to maintain a homogeneous adolescent sample. Finally, 14 participants were excluded because they self-reported that in the last four months they had either 6 or more menstruations or fewer than three menstruations. After applying these exclusionary criteria, a total of $n = 208$ adolescent girls were included in the analyses.

### *Questionnaire and procedure*

Participants were asked to fill out a 95-item online questionnaire on one of the first days of their menstruation. On average, most adolescent girls filled out the questionnaire on the second day of their menstruation (57%), which indicates that both premenstrual and menstrual days were included when answering the questions. The questions used to assess physical and psychological symptoms were based on a previously used menstrual cycle symptom questionnaire (Kiesner, 2009). The items included in this questionnaire are based on DSM-IV symptoms of PMDD, and other well-recognized symptoms of the menstrual cycle that are not listed in the DSM-IV (e.g., skin changes, see Williams & Cunliffe, 1973; lower abdominal cramps, see Freeman, Sondheimer, Weinbaum, & Rickels, 1985). The format and response scale was similar to those used in other questionnaires on premenstrual symptoms (Freeman, DeRubeis, & Rickels, 1996; Kiesner, 2009; Kiesner & Pastore, 2010; Steiner, Macdougall, & Brown, 2003). The questionnaire was filled out at school and with the supervision of a research

assistant. The overall time to fill out the questionnaire lasted approximately 15 min. In addition to the items and scales presented below, the questionnaire included items regarding general demographic information, identification with being a women, lifestyle, and menstrual history and regularity.

*Physical symptoms*

Participants were asked to report changes in physical symptoms in reference to the week prior to completing the questionnaire (e.g., on average 4–5 days premenstrual and 2–3 days menstrual). The presence and severity of the following six physical symptoms were measured: breast changes, back and joint pain, gastrointestinal problems, lower abdominal cramps, skin changes, and headaches. Responses were given using the following 5-point scale: 0 ("None"), 1 ("A Little"), 2 ("Some"), 3 ("Much"), and 4 ("Very Much"). The specific questions used to measure these physical symptoms are presented in Appendix A, and have been used in multiple studies (Kiesner, 2009; Kiesner & Pastore, 2010). To create a composite score, the mean of the standardized scores was first calculated for each physical symptom. Then, the sum of the standardized symptoms scores was used to create a single composite score of all six physical symptoms ($\alpha = .65$).

It should be noted that physical symptoms that are commonly associated with the menstrual cycle affect different tissues and frequently occur independently of each other (e.g., some women experience headaches but not cramps, and *vice versa*), and therefore high correlations (i.e., a high Cronbach's $\alpha$) should not necessarily be expected. However, past research has shown that a simple sum score of menstrual cycle-related physical symptoms (an index of symptom load) is strongly associated with menstrual cycle-related psychological symptoms (Kiesner, 2009).

*Psychological symptoms*

Participants were asked to report changes in psychological symptoms in reference to the week prior to completing the questionnaire (e.g., on average 4–5 days premenstrual and 2–3 days menstrual). The following three types of psychological symptoms were examined: depressed mood, cognitive symptoms, and mood swings. The responses for depressed mood were given on a 4-point scale ranging from 0 ("never or rarely") to 3 ("most of the time, always"), whereas the responses for cognitive symptoms and mood swings were given on the same 5-point scale used for physical symptoms: 0 ("None"), 1 ("A Little"), 2 ("Some"), 3 ("Much"), and 4 ("Very Much"). The specific questions are presented in Appendix A.

The three questions used to measure depressive symptoms were taken from the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977; see Appendix A). These three items were used because they focused specifically on depressive/sad mood, thus excluding social and vegetative symptoms that are typically part of depression scales, including the CES-D. This 3-item scale accounted for 87% of the variance of the total CES-D score, and demonstrated good internal consistency ($\alpha = .80$).

Although cognitive symptoms were measured using three items (see Appendix A), it should be noted that one other item regarding feeling "confused" was included to measure cognitive symptoms, but this item was dropped for the present analyses. Although all four of these items were significantly correlated (all $rs \geq .39$ and $\leq .54$), the item asking about feeling "confused" resulted in correlated residuals across other constructs in the structural equation models, and problems of fit. Therefore, this item was excluded from these analyses. The final 3-item scale demonstrated good internal consistency ($\alpha = .76$).

Finally, mood swings were measured with three items (see Appendix A). These items focused on irritability, emotional control, and changes in mood. This 3-item scale demonstrated good internal consistency ($\alpha = .89$).

It should be noted that the specific physical and psychological symptoms used in this study were chosen because they are listed in the DSM-IV criteria for PMDD (American Psychiatric Association, 1994) or because they have been shown in the published literature to be associated with the menstrual cycle (e.g., Kiesner, 2009; Kiesner & Pastore, 2010). Although other symptoms may also change in relation to the menstrual cycle, the symptoms that were chosen are among the most common and well documented.

*Changes in daily activities*

To measure changes in daily activities the following item with four response options was presented: "During days of menstruation (mark as many options you want):", to which participants could choose from the following responses: "I do less sports activities", "I go out less to see people", "I do not meet my obligations (work, class)", and "I do not change my daily habits". The item "I do not change my daily habits" was included to capture information regarding changes in daily activities that had not been listed, and was reverse coded. The three items regarding specific changes were averaged together. These two variables (behavior change, and reverse coded no-behavior change) demonstrated a strong correlation ($r = .86$) and were used to create a latent construct in the Structural Equation Models.

*Gynecological age*

To measure gynecological age, each girl's age at menarche was subtracted from her actual age, thus providing a metric of years passed since menarche ($M = 4.50$, $SD = 1.61$). Gynecological age has been demonstrated to be relevant, during adolescence, for symptoms related to psychological stress (such as depression, eating disorders, and obsessive compulsive disorder, Bisaga et al., 2002). Thus, this variable was considered to be an important control variable.

*Data analysis*

Because the mediational model is premised on a significant association between physical and psychological symptoms of the menstrual cycle, this association was first tested considering simple bivariate correlations between composite scores of the physical symptoms and the psychological symptoms. Structural equation modeling was used to test the mediational model, using the data analysis software R (packages lavaan version 0.5–16, Rosseel, 2012; gdata version 2.13.3, Warnes et al., 2014; semPlot version 1.0.0, Epskamp, 2014; R version 3.1.0, R Development Core Team, 2014). Specifically, a model was used to test whether effects of physical symptoms on psychological symptoms may be mediated through changes in daily activities.

This model included a single composite score of six physical symptoms, which was allowed to predict changes in daily activities, and the three psychological symptoms. Psychological symptoms were also predicted by changes in daily activities, thus allowing for a test of mediation of physical symptoms on psychological symptoms, passing though changes in daily activities. As a control variable, gynecological age was included as a predictor of physical symptoms and the psychological symptoms. The mediational model is presented in Fig. 1.

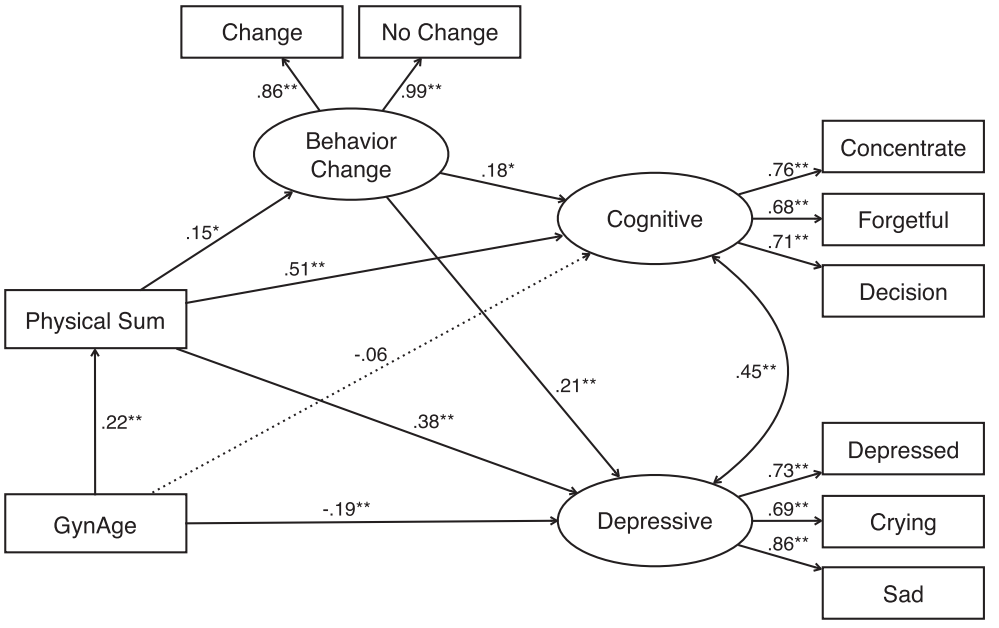
Because preliminary analyses indicated that changes in daily activities did not predict mood swings, mediation would not have been plausible for this construct, and it was therefore left out of this mediational analysis. Therefore, only cognitive symptoms and depressive symptoms were included as psychological constructs in this test of mediation.

This dataset had very little missing data: No variable had more than four missing data points. However, to avoid losing any participants, we estimated and imputed those missing data using the multivariate function in JMP 10 (SAS Institute, 2012), which imputes missing data based on the full pattern of correlations present in a multivariate correlation matrix utilizing all available data.

## Results

*Correlations among all measured variables*

The correlation between the composite score of physical symptoms and the composite score of psychological symptoms was $r = .54$, ($p < .001$; 2-tailed). Moreover, as can be seen in Table 1, the correlations among the separate symptom scores shows that the individual symptoms are also correlated amongst each other, with the strongest correlations between the different psychological symptoms, and the weakest correlations between the different physical symptoms. Thus, among this sample of adolescent girls, there are significant associations between the specific physical and psychological symptoms, as well as between the composite physical and psychological symptom scores. Therefore, further analyses testing for mediation are clearly justified.




$\chi^2 = 45.39$, $df = 28$, $p = .02$, CFI = .98, NNFI = .96, RMSEA = .05

**Fig. 1.** Structural Equation Model testing for effects of physical symptoms on psychological symptoms, mediated through behavioral change in daily activities.

**Table 1**
Correlations between specific physical and specific psychological perimenstrual symptoms.

| | Dep | Cog | MoodSw | Cramps | Pain | Breast | Gastro | Skin | Head |
|---|---|---|---|---|---|---|---|---|---|
| Dep | – | .44*** | .60*** | .20** | .27*** | .18* | .20** | .12 | .31*** |
| Cog | | – | .45*** | .23** | .29*** | .29*** | .31*** | .21** | .32*** |
| MoodSw | | | – | .38*** | .32*** | .34*** | .26*** | .12 | .38*** |
| Cramps | | | | – | .24*** | .32*** | .31*** | .24*** | .28*** |
| Pain | | | | | – | .32*** | .20** | .11 | .19** |
| Breast | | | | | | – | .19** | .23** | .31*** |
| Gastro | | | | | | | – | .05 | .38*** |
| Skin | | | | | | | | – | .16* |
| Head | | | | | | | | | – |

Note: *p < .05; **p < .01; ***p < .001.
The correlations within the box are the correlations between the physical and psychological symptoms ($n = 208$).

### *Mediation model*

Structural Equation Modeling was used to test the hypothesis that self-reported changes in daily activities would mediate the association between perimenstrual physical symptoms and perimenstrual psychological symptoms. Results show that the model fit the data well ($\chi^2 = 45.39$, $df = 28$, $p = .02$, CFI = .98, NNFI = .96, RMSEA = .05). As is presented in Fig. 1, physical symptoms significantly predicted changes in daily activities, as well as both psychological symptoms. Moreover, gynecological age predicted only depressed mood, and the two psychological symptom constructs were significantly correlated with each other. Importantly, the paths going from changes in daily activities to both psychological symptoms were significant and positive, indicating that individuals who reported more changes in daily activities as a result of the menstrual cycle, also reported higher levels of both cognitive and depressive symptoms.

Two tests of mediation were used. First, the criteria for the joint significance test of mediation were met (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), which supports the plausibility of a mediational hypothesis for both psychological symptoms. Second, using the Sobel test (Sobel, 1982), the indirect effect of physical symptoms on depressed mood was significant ($z = 1.77$, $p < .05$; one-tailed), and the indirect effect of physical symptoms on cognitive symptoms was significant ($z = 1.65$, $p = .05$; one-tailed). Together, the joint significance test and the Sobel test provide support for both mediation effects.

A second model was tested in which the paths going from changes in daily activities to the psychological symptoms were reversed. This tested the plausibility of mediation passing from physical symptoms to psychological symptoms then to changes in daily activities. The fit indices of this model demonstrated a small decrease in fit ($\chi^2 = 47.37$, $df = 28$, $p = .01$, CFI = .97, NNFI = .96, RMSEA = .06; $\Delta\chi^2 = 1.98$ with the same *df*s), and although the model converged one estimated residual variance was negative. Moreover, in this "reverse" model, neither of the paths going from the psychological symptoms to changes in daily activities were significant ($p$'s $\geq .18$).

Three points should be made regarding interpretation of this reverse model. First, because the degrees of freedom are the same in both models, it is not possible to test whether the change in fit is significant. However, it should be noted that the change is small, and our argument is not that one model fits statistically better than the other, but that the alternative model results in no improvement at all. The second point is that the reversed path coefficients also cannot be statistically compared to the original paths (i.e., to test whether they are significantly different). Specifically, the reversed path is a different effect, containing different indirect effects, and therefore is not comparable to the original paths, and a change in magnitude cannot be statistically tested. Finally, the main goal of this model was to test the plausibility that mediation could go in the other direction, and the results clearly suggest that this is unlikely. Based on the fit indices and the significance of the pathways, we argue that the reversed model does not support the hypothesis that mediation goes in the opposite direction of what is proposed by our model.

## Discussion

Consistent with past research (Kiesner & Pastore, 2010; Negriff et al., 2009), the findings of the present study confirm that, during adolescence, perimenstrual physical symptoms are significantly associated with perimenstrual psychological symptoms. In addition, these cross-sectional data are consistent with the hypothesis that the association between physical symptoms and psychological symptoms is partially mediated by changes in daily activities (i.e., going out with people, fulfilling school and work obligations, and engaging in sports), but only for depressed mood and cognitive symptoms. Changes in daily activities were not associated with mood swings and, therefore, mediation analysis were not conducted for this construct.

These results suggest that physical symptoms may have an influence on psychological symptoms both directly, as proposed by the *physical distress hypothesis* (Kiesner, 2009; Kiesner & Martin, 2013), and indirectly through perimenstrual disengagement from daily activities. Moreover, the symptoms and mediational processes examined in this study are not likely to remit or wane as adolescent girls mature. For example, research has shown that both affective symptoms (Patton et al.,

1996) and menstrual cycle-related symptoms (Beal et al., 2014; Cleckner-Smith et al., 1998) tend to increase across adolescence, and that menstrual cycle-related symptoms tend to remain stable from late adolescence to at least middle adulthood (Strine, Chapman, & Ahluwalia, 2005; Wittchen, Becker, Lieb, & Krause, 2002). In the context of the present findings, this suggests that the interference with daily activities is also *not* likely to remit, and that this interference may become chronically associated with disengagement and negative psychological changes.

Thus, given the age of onset and the long-term stability of these cyclical changes, these hypothesized mediational effects should be considered in the context of *cumulative continuity* (Caspi & Bem, 1990). Specifically, the current results suggest that physical symptoms reduce opportunities to engage in normal and important developmental activities, including school, sports, and spending time with friends, which may then lead to recurrent or chronic negative psychological outcomes. Although the present data are not longitudinal, it can be hypothesized that the negative effects found with the present study would have cumulative developmental consequences. Considering the efforts and expenses that schools and families invest to offer such opportunities, research should focus on understanding obstacles that may interfere with participation, including menstrual cycle-related symptoms.

It is also important to note the differences in mediational effects across psychological symptoms. In considering this difference, it should be mentioned that all three psychological symptoms demonstrated consistent and similar correlations with the physical symptoms. Nonetheless, mood swings were not associated with changes in daily activities, and were therefore not included in the mediational analyses; and, whereas the mediated effect for depressed mood was significant ($p < .05$), the mediated effect for cognitive change was at the limit of significance ($p = .05$). These differences suggest that different causal mechanisms may be linking these distinct psychological symptoms with physical symptoms. For example, because mood swings are acute and transitory they may depend more on acute and transitory physical changes than on broad changes in daily routines. Although speculative, this hypothesis is partially supported by the pattern of correlations (see Table 1) showing that mood swings, as compared to depression and cognitive symptoms, are more strongly associated with menstrual cramps, which is also an acute and transitory symptom. Furthermore, it is possible that depressed mood and cognitive symptoms also have different underlying causal mechanisms linking them with physical symptoms. For example, depressed mood may result from disappointment and feeling left out, whereas cognitive symptoms may result from physiological effects of decreased activity level on the peripheral and central nervous systems. Further research and theory is required in this area.

It is important to note that the correlations between the physical and psychological symptoms are generally stronger than the correlations among the physical symptoms. In addition to arguing against response bias as a determining factor in these results, these results also underline the importance of studying the robust, but poorly understood, correlation between physical and psychological symptoms of the menstrual cycle.

A specific comment must be made regarding cross-national and cross-cultural generalization of this model. As presented in the introduction, menstrual cycle-related symptoms have been reported across diverse national and cultural samples, including Swiss women (Angst, Sellaro, Stolar, Merikangas, & Endicott, 2001); African American adolescents (Houston et al., 2006); Italian women (Kiesner, 2009); Canadian, U.S., and Slovakian adolescents (Steiner et al., 2011); and Japanese women (Takeda et al., 2006). However, the present study tested a specific hypothesis regarding the potential causal relations among these variables, and cross-national or cross-cultural differences in the predicted model could be expected if various national or cultural groups differed in how they manage menstrual cycle-related symptoms. We are not aware of any research that has examined cultural differences in how these symptoms are managed, thus underlining the need to test the cross-cultural generalizability of the present model in future research.

If the present model is further supported with longitudinal research, prevention efforts could focus on recognizing and managing the various symptoms associated with the menstrual cycle. This could include the use of anti-inflammatories (for a review, see Marjoribanks, Ayeleke, Farquhar, & Proctor, 2015) or hormonal contraceptives (Zahradnik, Hanjalic-Beck, & Groth, 2010) to help manage physical and/or psychological symptoms. Another approach could involve life/time management skills that may facilitate engagement in school, social, and sports activities, even in the presence of periodic menstrual cycle symptoms. For example, using a menstrual cycle calendar to plan ahead regarding study time or sports training, may help maximize engagement and success in these important activities. Regardless of whether the mediational effects of the current model are validated, such efforts may help ensure that adolescent girls do not miss out on important developmental activities.

It should be noted that other theoretical models could also be hypothesized. For example, it could be hypothesized that physical and psychological symptoms are simply correlated symptoms that together result in withdrawal from daily activities. This alternative model, however, would not offer an explanation of why the physical and psychological symptoms are correlated, other than a simple co-variation across the menstrual cycle. Although it is not necessary that the association between physical and psychological symptoms be explained with a causal link, we believe that it is very plausible, that empirical evidence supports the hypothesis (e.g., Kiesner, 2009; Kiesner & Martin, 2013), and that the proposed model provides a rational and testable hypothesis, that also may have implications for intervention and prevention.

Four limitations of the present study should be noted. First, because all symptoms were measured using a retrospective questionnaire, causality cannot be inferred. Second, it is possible that self-reports of the menstrual cycle-related symptoms were biased due to illness or injury. For example, it is possible that adolescent girls who were not feeling well (due to a cold, the flue etc.) recognized certain symptoms as menstrual symptoms, instead of symptoms of illness. Third, the participants of the present study included only Italian students all from the same high school, and therefore the results cannot be generalized to other nationalities, other age levels, or the overall population of Italian adolescents. Fourth, because measures in this study

were all based on self-reports, the results may be influenced by a mono-method response bias. However, different patterns of effects across specific symptoms observed in the present study (mood swings vs. depressed mood), and in past research (Kiesner & Pastore, 2010), does not suggest that mono-method response bias is a significant factor in these results. Nonetheless, considering these limitations, future research should replicate the findings using a longitudinal design with prospective daily ratings of symptoms.

Finally, it should be noted that, although the data are cross-sectional, and causality cannot be unambiguously inferred, these data do allow a valid test of the plausibility of the proposed theoretical model. Importantly, many of the hypothesized effects are expected to happen concurrently. That is to say, perimenstrual physical symptoms should lead to behavioral disengagement within the same time frame (e.g., days), and these behavioral changes should lead to psychological changes also during the same time frame. More specifically, cramps that occur today should interfere with school, sports, and social activities today, and the psychological consequences of this disengagement should also occur at the same time. Although long-term effects are also expected, as discussed in the context of *cumulative consequences*, these long-term outcomes are hypothesized to depend on the repeating occurrence of the temporally proximal effects. Moreover, given the almost complete lack of research in this area, and especially the lack of theoretical models, the test of the present model represents a significant and novel contribution.

Although the above limitations must be considered, this study makes unique and important contributions. Most importantly, the plausibility of changes in daily activities as a mediator between physical and psychological perimenstrual symptoms was demonstrated. This research provides a novel direction for research aimed at understanding affective and general psychological wellness of developing adolescent girls. The present study should be considered in the context of the many studies on adults, and the growing literature on adolescents, demonstrating that menstrual cycle-related symptoms are significant stressors that can potentially create disturbances in adolescent girls' psychological and behavioral development.

## Acknowledgments

Funding and support for this study was provided by an Innovative Research Grant from the Università Degli Studi di Padova. The co-authors, Jeff Kiesner, Massimiliano Pastore, and Ron H. J. Scholte, have all contributed significantly to this work. The findings of this study were previously presented at the 2014 SRA Biennial Meeting (March 20–22, Austin, TX).

## Appendix A. Questions for measurement physical and psychological symptoms.

| | Physical symptoms |
|---|---|
| Breast changes | … did you have changes in the sensitivity of your breasts? |
| | … did you have breast pain? |
| Back and joint pain | … did you have joint pain? |
| | … did you have back pain? |
| Gastrointestinal symptoms | … did you have gastrointestinal problems? |
| | … did you have burning or acidic stomach? |
| Lower abdominal cramps | … did you have lower abdominal cramps? |
| Skin changes | … did you have acne? |
| | … did you have an oily skin? |
| Headaches | … did you have headaches? |
| | **Psychological symptoms** |
| Depressed mood | … I felt depressed. |
| | … I had crying spells. |
| | … I felt sad. |
| Cognitive symptoms | … did you have difficulty concentrating? |
| | … did you have difficulty making decisions? |
| | … were you forgetful? |
| Mood swings | … did you feel you would lose emotional control? |
| | … did you feel irritable? |
| | … did you have mood swings? |

Note: All questions started with a stem phrase “During the last week …”.

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