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Getting a good night's sleep in adolescence: Do strategies for coping with stress matter?

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Abstract

Getting a good night's sleep is challenging for adolescents because of early school start times and adolescents' substantial social and physical changes. We tested whether key indices of sleep health are associated with usual styles of coping with stress and interpersonal conflict in healthy black and white adolescents. 242 (57% female, 56% black) high school students completed daily sleep diaries, questionnaires, and actigraphy across a school week. Linear regression models tested associations, independent of race, gender, and other covariates. Students who reported using disengagement coping exhibited poor sleep health. They had shorter sleep duration, more fragmented sleep, delayed sleep, and increased daytime sleepiness. Unexpectedly, positive engagement coping was related to daytime sleepiness and delayed sleep, although not in models that included disengagement coping. Coping strategies may be an important influence on adolescent sleep. Future research should evaluate the antecedent-consequent relationships among coping, sleep, and stress.

Keywords

Adolescence; sleep; stress; coping; race

Introduction

Adolescence is a period of intense growth and physical development, and a circadian shift, resulting in a biologically-based tendency to stay up late and sleep in when possible (Carskadon, 2008). Time spent sleeping on school nights decreases from childhood through adolescence, such that adolescents accumulate a sleep "debt" during the school week that is due, in part, to increases in social and educational demands and the mandatory early start times prevalent in high schools in the United States (Knutson & Lauderdale, 2009). In addition, adolescent sleep characteristics begin to reflect those of adults, which are characterized by increased wakefulness after sleep onset and reductions in slow-wave sleep (Dahl & Lewin, 2002). Daytime sleepiness increases during mid-adolescence, regardless of

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how much sleep is obtained during the night (Carskadon & Acebo, 2002; Wolfson, Spaulding, Dandrow, & Baroni, 2007).

Given that most adolescents are healthy, why should sleep be of concern? Substantial evidence suggests that poor sleep is associated with poor school performance, obesity, and increased accident and injury rates in children and adolescents (Cappuccio et al., 2008; Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010). Lack of nighttime sleep is also associated with increased negative mood and less adequate emotional regulation, which may negatively impact behavioral choices and interpersonal relationships (Cousins, Bootzin, Stevens, Ruiz, & Haynes, 2007; Mullin et al., 2013; Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). A few papers also suggest short sleep duration may also be associated with insulin resistance, and elevated lipids, nighttime blood pressure, and inflammation in adolescence (Kong et al., 2011; Larkin et al., 2005; Matthews, Dahl, Owens, Lee, & Hall, 2012; Mezick, Hall, & Matthews, 2012). Given the potential untoward consequences of poor sleep in adolescents and the changes in sleep patterns that occur during adolescence, it is important to understand the factors that may influence sleep in this developmental group.

Essential dimensions of sleep health are not only defined by the duration of sleep but also by whether sleep is fragmented, delayed in the context of the 24 hour period, experienced as poor quality, and leads to daytime sleepiness (Buysse, 2014). Good sleep requires individuals to have a sense of safety, security, and predictable environments. If individuals feel threatened or worried, they may be vigilant and ruminate, leading to short, fragmented sleep (Astill, Verhoeven, Vijzelaar, & Van Someren, 2013; Hall, Dahl, Dew, & Reynolds, 1995). Short, fragmented sleep is likely to be perceived as low quality and result in daytime sleepiness compared to longer, less fragmented sleep.

What types of daily events may cause adolescents to feel threatened or worried vs. safe and secure? Frequent conflicts with parents, family members, and peers are likely to be disturbing and may extend to disrupting sleep. Indeed, childhood family conflict is prospectively associated with insomnia symptoms in adolescents (Gregory, Caspi, Moffitt, & Poulton, 2006) and to self-reported poor sleep quality in adults (Koskenvuo, Hublin, Partinen, Paunio, & Koskenvuo, 2010).

Another factor to consider is ineffective strategies for coping with the demands of adolescence. In general, coping strategies involving disengagement or avoidance of stress-related thoughts and feelings and venting negative feelings are usually associated with greater distress and worse health outcomes (Taylor & Stanton, 2007). It may be that strategies that allow one to avoid problematic situations and to vent feelings do not lead to resolution of difficulties and may lead to an exacerbation of problems, thereby disturbing sleep. On the other hand, coping strategies that involve actively engaging problems, positively interpreting situations, and using humor lead to quicker resolution of difficulties, thereby allowing a greater sense of safety and security.

The extent to which these coping resources apply to understanding adolescent sleep is largely unknown. In one prospective study, Israeli undergraduates who typically used problem solving strategies to cope with stress had longer sleep, regardless of stressful

circumstances, whereas those who used more emotion-focused coping had shorter sleep during a stressful week and longer sleep during a nonstressful week (Sadeh, Keinan, & Daon, 2004). In a more recent study, support coping led to longer, more efficient sleep among African American children, but not among white children (El-Sheikh, Kelly, Sadeh, & Buckhalt, 2014).

The present paper evaluates how key aspects of sleep health measured across one week in healthy black and white adolescents are related to coping resources and exposure to interpersonal conflicts during the week. We hypothesized that adolescents with worse sleep health, i.e., shorter, more fragmented, and lower quality sleep, and more delayed sleep and daytime sleepiness, would report more often using disengagement strategies and less often positive engagement strategies. We anticipated that adolescents who reported more interpersonal conflict during the week would have worse sleep health. Because in the present sample and in other diary and survey studies, black children and adolescents have shorter sleep duration than whites, but report fewer insomnia symptoms (Matthews, Hall, & Dahl, 2014), our analyses explored whether the hypothesized relationships would vary by race and gender.

Methods

Participants

A sample of 250 adolescents from a single public high school participated in a study of stress, sleep, and cardiovascular risk factors. The school served about 500 students each year, with 63% eligible for free or reduced lunch, compared to 26% statewide. In the three years of the study, the high school graduated 83%; district performance was ranked as 111 out of 123 high schools in western Pennsylvania. The school was selected because it served a lower to middle socioeconomic status (SES) community, was racially diverse, and maximized the potential for SES to be similar for black and white students, allowing evaluation of the influence of race, independent of SES. Approval of the research project was obtained from the school district superintendent, school principal, and the University of Pittsburgh Institutional Review Board. Participants (or parents/ legal guardians for students under the age of 18) provided written informed consent prior to any research procedures. In addition to the 250 students who participated, 7 students signed consent forms but did not begin the study and 16 volunteered but were ineligible for the study based on the following exclusionary criteria: treatment for cardiovascular disease (CVD) or diabetes, medication use for emotional or psychological disorders, diabetes, blood pressure, or any medication known to affect the cardiovascular system or sleep. The final sample was 47% male and 56% black.

Overview of Protocol

Investigators and staff briefly presented the study in the high school's health and physical education classes and students signed up to receive more information. They and their parents/legal guardians were informed about the details of the study and the eligibility criteria by telephone and/or face to face interviews. The parents also were asked about family SES and parental cardiovascular health and the consent form was reviewed. The

parental interviews, exclusive of reviewing the consent forms, took approximately 20 minutes. The study protocol consisted of a fasting blood draw for measuring cardiovascular risk factors, anthropometric and blood pressure measures, a week of actigraphy while simultaneously completing diaries on a handheld computer in the morning and evening regarding bedtime, wake-up time, naps, and daily events, and questionnaires that were completed on a protected website at some point during the study protocol. The anthropometric measures were taken the first day of the study protocol, whereas the fasting blood draws by the phlebotomist were scheduled for the morning of one school day, depending on her and the students' availability. Staff contacted students midweek to assure completion of diaries and troubleshoot any problems in obtaining data. After completing the protocol, each participant was provided a personalized set of risk factor and sleep data. When the study was complete, the students, parents, and school administration were provided overall study results.

Measures

Demographic information—Age, sex, and race/ethnicity were determined by adolescent report, whereas other family measures were determined by interview of the parent or guardian, except for six who moved, refused, or were in jail. Paternal and maternal education was coded in years and in highest attained degree. Current occupation for both parents (if contributing to the household income) was coded into modified Hollingshead categories and combined with educational attainment to yield an overall score.

Sleep—The Mini-Mitter actiwatch model AW-16 (Philips Respironics, Bend, OR) was used to collect actigraphy data continuously over 7 days and nights. Actigraphs were configured to collect data over a 1-minute epoch. Stored data were downloaded into the Actiware software program (version 5.57) for processing and analysis [see (Matthews et al., 2012) for more details]. The medium threshold (default) was selected to detect nocturnal sleep periods of at least 3 hours in duration based upon sleep onset and offset using the 10-minute criteria. Total sleep duration was calculated as the time spent asleep between initial sleep onset and final sleep offset, excluding periods of wakefulness throughout the night (WASO). Sleep fragmentation, a measure of restlessness, was calculated as ([%1-minute intervals of movement during sleep + % 1-minute intervals of immobility] divided by total 1-minute immobility intervals). In this sample, it is highly correlated with WASO, a standard measure of sleep continuity, $r(247) = .77$, $p < .0001$. Sleep duration and fragmentation were averaged across the week. The actiwatch has been widely used in research studies and has been validated against polysomnography measures in clinic (Kushida et al., 2001; Tryon, 2004). Sleep quality was based on the sum of two statements in the morning diary, each rated on a 6 point scale, "**NO!** NO, no, yes, YES, **YES!**": "This morning I feel rested." and "My sleep last night was very good." The two items are highly correlated, $r(245) = .78$, $p < 0001$, and were averaged across the week; the alpha coefficient was 0.80.

Two subscales of the Sleep Habits Survey (Wolfson & Carskadon, 1998) were completed. The delayed sleep subscale consists of 6 items assessing the frequency of the following behaviors in the past two weeks in the context of school hours: arrived late to class because of oversleeping, stayed up past 3 a.m., stayed up all night, slept past noon, need more than

one reminder to get up in morning, hard time falling asleep. Participants rated the frequency of each behavior on a scale ranging from 1 (*never*) to 5 (*every day/ night*) and were totaled. Total sleep delay scores were correlated with diary-reported mean and standard deviation bedtime across the week, rs (243) = .32 and .24, ps < .001 respectively; alpha coefficient of the Sleep Delay scale was 0.63. The Daytime Sleepiness subscale consisted of 10 items regarding situations in which they may have struggled to stay awake or fallen asleep in the past two weeks, e.g., attending a performance, in class at school, or driving a car. These situations were rated on a four point scale from no, struggled to stay awake, fallen asleep, or both struggled to stay awake and fallen asleep, and were totaled. The alpha coefficient was 0.56.

Coping Resources—To reduce respondent burden, 23 items were used from the 53- item Adolescent Coping Orientation for Problem Experiences (ACOPE) (Patterson & McCubbon, 1987). The ACOPE has 12 factor scores. Because of the overall purpose of the project, we chose a broad range of items from 10 of the 12 factors, usually the higher loading items. These 10 factors were venting feelings (four items); seeking diversions (three items); developing self-reliance (three items); developing social support (one item); solving family problems (four items); avoiding problems (two items); engaging in demanding activity (two items); being humorous (two items), relaxing (two items); and seeking spiritual support (one item). On a five point scale ranging from “never” to “most of the time”, participants were asked how often they used different means of coping “when you face difficulties or feel stressed.” Factor analysis of the items summed within the original factor scores of the ACOPE followed by varimax rotation yielded three factors above eigenvalue of 1. Items on the subscales loading on the first factor (eigenvalue = 2.71) labeled Positive Engagement were “try to improve yourself”; “try to think of the good things in life”; “try on your own to figure out how to deal with problems and tensions”; “try to see the good in a difficult situation”; “joke and keep a sense of humor”; “try to be funny and make light of it”; and “do strenuous physical activity”. All loadings were > .70, alpha coefficient = .73). The second factor labeled Disengagement (eigenvalue = 1.46) was composed of items: “listen to music”; “eat food”; “get angry and yell at people”; “let off steam by complaining”; ‘blame others”; “watch TV or DVD”; “play video games or surf the web”; “drink beer, wine, liquor”; and “sleep”. The last item was removed from the factor score due to confounding with indices of sleep health. All loadings were > .53, alpha coefficient = .65). The items loading on each factor were then averaged for analysis.

Interpersonal conflict—In the daily nighttime electronic diary, participants were asked whether any of the following had happened that day: arguments/tension with family; arguments/tension with friends, and arguments/tension with others (teacher, principal, boss, etc.) Responses were aggregated across the seven days and categorized as follows: no arguments reported during the sampling period (18%); arguments reported on up to one third of diaries completed (26%); arguments reported on one to two thirds of the diaries completed (33%); and arguments reported on two thirds to 100% of diaries completed (24%).

Physical activity, body mass index, and depression—Questions regarding health behaviors were drawn from the Youth Behavior Checklist from the Center for Disease Control 2006 version. These questions concerned the number of days in the last seven that they were physically active at least 60 minutes per day. Height was measured using a stadiometer, and weight was measured on a Tanita digital scale. Body mass index (BMI) was calculated using the National Heart, Lung, and Blood Institute on-line calculator and percentiled against national norms by age and gender (National High Blood Pressure Treatment Program, 2004). The Center for Epidemiologic Depression Scale (CESD) (Radloff, 1977) was used as a measure of depressive symptoms after removal of the item, "my sleep is restless" due to confounding with indices of sleep health. This scale has been used extensively including among adolescents (Roberts, Andrews, Lewinsohn, & Hops, 1990). These measures were used as covariates as all have been associated with sleep characteristics in adolescent samples.

Statistical analyses—Analysis was based on 242 students out of 250: 1 had missing actigraphy data because of equipment failure and one had only 2 days of data (who also was missing questionnaire and diary data in addition to the 3 below); 2 had extreme values of BMI (more than four standard deviations above the mean), 1 had implausible values whose parent reported the participant as being unreliable, and 3 had no questionnaire and/or diary data. Family Hollingshead data were missing for 6 participants but because these scores were unrelated to any sleep measures, ps > .10, we did not use it as a covariate. Data were transformed for variables with skewed distributions (fragmentation, CES-D, and BMI percentile) to ensure normality. To address whether the predictors, covariates, and sleep measures varied by gender and race, 2 (Gender) x 2 (Race) ANOVAs were conducted. Interrelationships among predictor variables were evaluated by Pearson correlation. Hypotheses were tested by a series of linear regression models with each of the three predictor variables (taken one at a time). Models were adjusted for race and gender because they were related to both the predictor variables and to the outcomes and for self-rated physical activity, BMI percentile, and CES-D (for self-report measures only) because these factors affect sleep. CES-D was unrelated to actigraphy measures of duration, p = .19, and fragmentation, p=.41, but was related to the self-report measures, ps < .003. Supplemental analyses evaluated interactions of race or gender with the predictor variables, and the interactions of coping and conflict measures. P-values were considered statistically significant at <.05.

Results

Sample Characteristics

The sample was composed of 66 black males, 76 black females, 50 white males, and 58 white females. For those in the analyses, their average age was under 16 years; see Table 1. The sample was from low to middle class as evidenced by their family Hollingshead scores (10 to 54), with black students more often from families with higher Hollingshead scores. The sample tended to be overweight or obese. They reported being physically active about half the days in the past week, with greater physical activity among males. The CES-D scores were relatively high, characteristic of high school students (Roberts et al., 1990), with

females and whites reporting more depressive symptoms. Females and whites reported they had proportionately more days with conflicts with others. Females and whites reported more depressive symptoms and greater use of disengagement coping than males and blacks, respectively. Males reported greater use of positive engagement coping.

Positive and disengagement coping scores were modestly related, r (244) = .23. Disengagement coping was associated with more daily conflict and depressive symptoms, r (241) = .24 and .r (244) = .35, ps < .01, respectively.

Sleep Characteristics

As reported elsewhere, participants' sleep was short in duration across the full week (Matthews et al., 2014). The mean scores for daytime sleepiness were in the normal range for high school students, with delayed sleep scores somewhat higher than previous reports (Acebo & Carskadon, 2002). Shorter sleep duration was related to more fragmented sleep, delayed sleep, and daytime sleepiness scores. Delayed sleep and daytime sleepiness were modestly related. Sleep quality was unrelated to any indices.

Associations of predictor variables with sleep health

As shown in Table 2, our hypothesis regarding the negative impact of disengagement coping on sleep was confirmed. Participants who reported greater disengagement coping had shorter sleep duration and more fragmented sleep throughout the week and reported more delayed sleep and daytime sleepiness. On the other hand, our hypothesis concerning the positive impact of positive engagement coping was not confirmed. In fact, positive engagement coping was also related to more delayed sleep and daytime sleepiness.

Our hypothesis concerning interpersonal conflict was also not confirmed. Participants who reported more days of interpersonal conflict during the sleep protocol did not differ in their sleep health from those who reported less.

Supplemental Analyses—Coping strategies did not interact significantly with interpersonal conflict. Of the 30 interactions tested for race or gender with coping or conflict, one was significant, p = .05. More days of daily conflict were associated with lower sleep quality reported in the diaries by whites, p = .0004, with no relationship in blacks, p = .59.

Because both positive engagement and disengagement strategies were associated with delayed sleep and daytime sleepiness, we questioned if participants who reported using numerous coping strategies had these sleep characteristics. A simple count of number of strategies reported being used "often" or "most of the time" was associated with delayed sleep and daytime sleepiness, ps < .001. When both the disengagement and positive engagement coping were forced into the same model, only disengagement coping was statistically significant, ps < .007.

Discussion

Our study tested the associations of usual coping strategies and exposure to conflict throughout the day with key dimensions of sleep health in healthy adolescents. Our results were consistent with the hypothesis that participants who typically use disengagement coping have worse sleep on a number of the key indicators of sleep health. They had more delayed sleep and more daytime sleepiness and shorter sleep duration and more fragmentation. These findings are largely consistent with other data on the effects of disengagement coping on prolonging distress and negatively impacting health indicators (Herman-Stahl, Stemmler, & Peterson A C, 1995). Thus, our findings extend the potential negative consequences of disengagement coping to poor sleep.

On the other hand, positive engagement coping was not associated with better sleep. Rather, participants who reported that they usually used positive engagement strategies had more delayed sleep and more daytime sleepiness. However, positive engagement coping was no longer significantly associated with these measures when disengagement coping was introduced into the same models. At the present time, we think it is unlikely that positive engagement coping is protective of sleep health among adolescents, perhaps because of the over-riding demands of school and work schedules on their time, or because of the relatively disadvantaged community of the study population.

Aside from studies on post-traumatic stress disorders or correlational studies of subjective sleep reports and stress, it has been surprisingly difficult to document consistent associations with stress. In a review article of 63 studies that used polysomnography methods, Kim and Dimsdale (Kim & Dimsdale, 2007) concluded that many studies found no effect of stress on sleep parameters in adults. In the subset of nine studies that used daily stress and stressful life events measures, the findings were mixed, with the best evidence for stress affecting sleep continuity. More recently, sleep duration as measured by actigraphy was unrelated to concurrently measured daily hassles among 87 young adults of Asian, European, and other backgrounds (Hanson & Chen, 2010).

We explored whether our two coping measures would interact with interpersonal conflict throughout the week in their association with sleep characteristics. They did not. Thus, it appears that these relationships are independent of one another, at least in an adolescent population. A recent review showed that psychological resources or absence thereof was more important in understanding the psychosocial pathways connecting socioeconomic status and health than were stress measures, and that they rarely interacted (Matthews, Gallo, & Taylor, 2010). Perhaps that is the also the case for sleep health. Because gender and race differences exist in sleep measures in this and other samples, we explored whether the influence of stress, distress, and coping would vary by gender and race. We conclude that there are no convincing differences in the pattern of results by gender and race.

The study has a number of limitations and strengths. Regarding limitations, the study design is cross-sectional and antecedent-consequent relationships cannot be described. Thus, disengagement coping and conflict may be a consequence of poor sleep leading to poor coping and difficulties dealing with conflict rather than vice versa. The precise timing of

completing online questionnaires measuring stress, coping, sleep delay, and daytime sleepiness was allowed to vary within the week-long protocol. Second, the sleep measures did not include polysomnography to characterize sleep apnea or sleep stages; we only had a parental/caregiver screen for symptoms of sleep disordered breathing. Third, the measures of usual coping were composed of a subset of items from the original scale, which may have played a role for the inconsistent relationships with positive engagement. Fourth, the findings are based on students enrolled in a single high school that served low to middle class families. Thus, the findings cannot be generalized to more affluent communities. Regarding strengths, the sample was diverse and was composed of blacks and whites, males and females, who were healthy based on parental interview of their children's medical history. Second, the measures of sleep were detailed and appropriate for testing high school students in a school/home setting. Third, it benefited by measuring the major dimensions of sleep health, including objective measures of sleep duration, as opposed to self-reported sleep duration only. Thus, we believe our sleep measures provide a valid picture of the students' sleep health across a school week.

In summary, students who typically used disengagement coping had poor sleep health on a number of key indicators. Future research would benefit from a more detailed assessment of coping strategies during the week in response to specific stressors to examine the antecedent and consequent relationships among coping, conflict, and sleep health. Improving ways of coping with stress may lead to a good night's sleep in adolescence and is worthy of future experimental investigation.

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Table 1

Sample characteristics

	Black		White		Total
Mean (SD)	**Male**	**Female**	**Male**	**Female**	
Age (yrs)	15.7 (1.2)	15.7 (1.1)	15.7 (1.5)	15.6 (1.1)	15.7 (1.3)
Duration[b,c]	6.2 (.8)	6.3 (.6)	6.4 (.7)	6.9 (.9)	6.4 (.8)
Fragmentation[a,b]	34.4 (10.9)	31.4 (10.4)	28.0 (6.7)	27.0 (8.3)	30.5 (9.8)
Quality[b]	8.9 (1.6)	8.0 (1.9)	8.4 (1.8)	7.7 (1.8)	8.2 (1.8)
Delayed sleep	12.8 (4.2)	13.9 (4.6)	13.3 (3.9)	13.4 (4.3)	13.4 (4.3)
Daytime Sleepiness	15.9 (3.9)	16.3 (3.6)	15.3 (3.7)	16.3 (3.4)	16.0 (3.6)
Family Hollingshead Score[a]	33.5 (12.0)	30.5 (11.6)	29.0 (11.5)	27.6 (10.2)	30.3 (11.5)
Body Mass Index percentile	79.6 (19.8)	81.3 (19.5)	80.6 (24.6)	72.7 (26.8)	78.7 (22.7)
Days physically active ≥ 60 min in last week[b]	4.4 (2.3)	3.2 (2.3)	3.9 (1.9)	2.6 (2.1)	3.5 (2.3)
Daily interpersonal conflict groups N (%)[a,b]:					
0 days	20 (30.3)	10 (14.3)	10 (20.8)	4 (6.9)	44 (18.2)
< 1/3 days	20 (30.3)	19 (27.1)	14 (29.2)	9 (15.5)	62 (25.6)
1/3 – < 2/3 days	16 (24.2)	30 (42.9)	16 (33.3)	17 (29.3)	79(32.6)
≥ 2/3 days	10 (15.2)	11 (15.7)	8(16.7)	28 (48.3)	57 (23.6)
CES-Depression [a,b]	12.4 (6.8)	16.8 (8.5)	15.5 (9.3)	21.3 (9.5)	16.4 (9.0)
Coping:					
Positive Engagement [b]	3.4 (0.7)	3.2 (0.8)	3.4 (0.7)	3.1 (0.6)	3.3 (0.7)
Disengagement [a,b]	2.7 (0.5)	2.9 (0.6)	2.8 (0.6)	3.1 (0.6)	2.8 (0.6)

[a]Race main effect, p<.05

[b]Gender main effect, p<.05

[c]Race x Gender interaction from 2(Race x) 2(Gender) ANOVA, p = .05

Table 2

Unstandardized Regression Coefficients (Standard Errors) from Linear Regression Models predicting Sleep Health Indices from Measures of Coping and Conflict

	Disengagement	Positive Engagement	Daily Conflict
Duration	−.19 (.08)*	.02 (.07)	−.03 (.05)
Fragmentation	.07 (.03)*	.01 (.03)	−.03 (.02)
Quality	.33 (.20)	.27 (.16)	−.22 (.12)
Delayed Sleep	2.70 (.47)***	1.21 (.40)**	.28 (.29)
Daytime Sleepiness	.99 (.41)*	.69 (.33)*	.36 (.24)

Note: Models adjusted for race, gender, BMI percentile, physical activity, and depressive symptoms (CES-D for self-report measures only).

* p≤ .05,

** p≤.01,

*** p≤.001