Abstract

Background: The aim of the present study was to explore the association between mental toughness (MT), subjective sleep (sS), physical activity (PA), and **quality of life (QoL)** during early and mid-adolescence.

Methods: A total of 1475 participants (mean age=13.4 years; range: 11-16 years) took part in the study. They completed questionnaires related to MT, PA, sS and **QoL**.

Results: Greater MT was related to **more favorable QoL** and increased sS. MT was not related to PA.

Conclusions: Increased MT, favorable **QoL** and sleep are related during early and mid-adolescence. Against our expectations, MT was not related to PA.

Key words: mental toughness; subjective sleep; physical activity; **quality of life (QoL);** early and mid-adolescence

Introduction

Adolescence is marked by a vast array of social, emotional, cognitive, and behavioral changes, with conceptually distinct physical changes and neural networks marking puberty and maturation (Pinyerd & ZiQoL , 2005; Spear, 2000; Giedd, Blumenthal, Jeffries, Castellanos, Liu, Zijdenbos, et al., 1999; Paus, Kashavan, & Giedd, 2008). Adolescents have to face new challenges and assume responsibility for issues such as their academic and vocational careers, peer and intimate relationships, increased physical, emotional and financial independence from parents and siblings, use of psychoactive substances, extra-curricular employments and leisure-time activities such as sports participation and music (cf. Spear, 2000). Dealing with these issues is potentially stressful and, accordingly it is assumed that adolescent with better coping skills will deal more successfully with these challenges (Grant, Compas, Thurm, McMahon, Gipson, Campbell, et al. (2004).

A psychological construct related to favorable stress management is mental toughness. Mental toughness (MT) is a relatively new area of academic research (Gucciardi & Gordon, 2011), and a cognitive strength variable known to be associated with good performance both in elite sport (Crust & Azadi, 2012) and, more recently, also in non-elite sport (Gerber, Kalak, Lemola, Clough, Pühse, Elliot, et al., 2012; Gerber, Brand, Feldmeth, Lang, Elliot, Holsboer-Trachsler, et al., 2013; Gerber, Kalak, Lemola, Clough, Perry, Pühse, et al., 2013). Mental toughness has been conceptualized in various ways in the scientific literature (see Jones &

Parker, 2013, for review). In the present study, we used the 4C model of mental toughness[1] defined as performing well in Challenging situations, Commitment, Control (emotional control, and life control) and Confidence (interpersonal confidence, and confidence in ability; Clough, Earle, & Sewell, 2002; see Table 1 for typical items).

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Table 1

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1 How to distinguish mental toughness from resilience? The construct of resilience is an unexpected positive adaptation despite a high risk for maladjustment, when exposed to psychosocial adversities (Cicchetti, 2010; Luthar, Cicchetti and Becker, 2000; Masten, 2001). Resilience is not an innate attribute of an individual, but represents a dynamic concept and can change with time (Rutter, 1993). Recent studies have shown, that for instance among adolescents suffering from type 1 diabetes higher scores of resilience were associated with lower distress, increased quality of life and higher glycemic control (Yi-Frazier, Yaptangco, Semana, Buscaino, Thompson, Cochrane et al., in press). Likewise, Dageid and Gronlie (in press) showed that among HIV-positive patients resilience was related to education, income, and self-rated health. By contrast, mental toughness as a personality disposition is a resilience resource, that is a protective factor, which helps individuals coping with stress.

In previous studies (Gerber, et al., 2012, Gerber, Brand et al., 2013; Gerber, Kalak et al., 2013) we have been able to validate the German version of the Mental Toughness Questionnaire 48 (MTQ48; Clough, et al. 2002) and to show, in a large sample of adolescents and young adults, 1) that the construct of mental toughness (MT) is not limited to high performing elite athletes (Gerber, et al., 2012, Gerber, Brand et al., 2013; Gerber, Kalak et al., 2013) , 2) that MT it is associated with increased stress resilience (Gerber, et al., 2012, Gerber, Brand et al., 2013; Gerber, Kalak et al., 2013), 3) that MT it remains relatively stable over time (Gerber, Brand et al., 2013), 4) that MT is associated with higher physical activity levels (Gerber, et al., 2012; Gerber, Kalak et al., 2013), 5) that relative to males, females reported lower MT, and that greater MT was associated both with favorable 6) subjective (Brand, Gerber, Kalak, Kirov, Lemola, Clough, et al., 2014a) and 7) objective sleep (Brand, Gerber, Kalak, Kirov, Lemola, Clough, et al., 2014b), suggesting therefore that MT is related to successful stress management, psychological wellbeing, favorable sleep and increased physical activity.

However, for young adolescents, research on this topic does not exist so far. The aim of the present study was therefore to investigate the association between MT, subjective sleep, **quality of life (QoL)** and PA in adolescents aged 11-16 years. Based on previous research (Gerber, et al., 2012; Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013; Brand, et al., 2014a, b), we hypothesized that greater MT was associated with increased PA, decreased sleep disturbances[2] and greater **quality of life (QoL)**. Also, we predicted more unfavorable

2 A previous study showed (Brand et al., 2014b) that subjective and objective sleep do highly correlate. In the present study, given the large sample size, we exclusively assess subjective sleep. We note that self-reported sleep is the golden standard, when assessing sleep in larger samples (cf. Wolfson, Carskadon, Acebo, Seifer, Fallone, Labyak, and Martin, 2003).

values in female as compared to male participants. Moreover, we treated as exploratory the extent to which MT, PA and subjective sleep might predict **quality of life (QoL)** as expressed by a global health-related quality of life index.

Methods

Sample

A total of 1475 adolescents (mean age: 13.4 years; range: 11-16 years; 48.8% males) took part in the study. Adolescents were recruited from five middle schools in the Cantons Basel, Basel-Land, and Aargau, three districts in the northwestern of the German-speaking part of Switzerland. Participants and participants' parents were informed about the purpose of the study and about the voluntary basis of their participation. They were also assured of the confidentiality of their responses, and written informed consent was obtained from both participants and parents. Data collection took place in spring 2013. Participants completed the questionnaire booklet during a school lesson; the booklet was completed within 20-35 minutes. During data collection in the classroom, professional staff members provided examples on how to complete the items in the questionnaire booklet.

The study protocol was carried out in accordance with the Declaration of Helsinki, and the local ethics committee approved the study.

Material

Mental toughness

Participants were asked to fill in the 48-item Mental Toughness Questionnaire (MTQ48; Clough, et al., 2002; German version: Gerber, et al., 2012; Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013). The questionnaire measures the following subcomponents (see also Table

1): challenge, commitment, emotional and life control, and interpersonal confidence and confidence in ability. Answers on the MTQ48 are given on five-point Likert-type scales ranging from 1 (=strongly disagree) to 5 (=strongly agree). Items were summed, with higher scores reflecting greater subcomponents of MT; moreover, all subcomponents were aggregated to a MTQ48 overall score (Cronbach's alpha=.91).

Quality of life (QoL)

Participants completed the KID-SCREEN 52 (Ravens-Sieberer, Gosch, Rajmil, et al., and the KDSCREEN Group, 2008). The questionnaire consists of 52 items focusing on ten different domains of children's and adolescents' social, physical and **quality of life (QoL):** physical functioning, psychological functioning, moods and emotions, self-perception, autonomy, parent relation and home life, financial resources, social support and peers, school environment and social acceptance. Answers are given on 5-point Likert scales, with the anchor points 1 (=not at all) and 5 (=extremely/always). The 10 domains are aggregated to the following subscales: Physical wellbeing, psychological wellbeing, relationship to parents and autonomy, relationship to peers, school environment, and social acceptance. Moreover, a global health-related quality of life index is calculated. Higher mean scores reflect a higher functioning in the respective domains (Cronbach's alpha for the overall index =.92).

Moderate to vigorous physical activity (PA)

To assess PA, participants were asked on how many days per week they exercised or participated in (high intensity) activities and sports. The response categories ranged from 0 to 7 days. In addition, participants were asked to indicate the average duration (per day) for the days they engaged in these activities. Multiplication of frequency and duration scores resulted in an estimate of weekly hours invested in vigorous PA. In addition, participants were asked

to indicate how many days per week they engaged in moderate PA. Again, an additional question asked about duration per day in order to estimate the weekly engagement (hours/week) in moderate PA. All items were taken from the International Physical Activity Questionnaire (Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth, et al. 2003). Validity of such general items is considered acceptable in samples of adolescents (Hagströmer, Bergman, De Bourdeaudhuij, Ortega, Ruiz, Manios, et al., 2008). Ottevaere, Huybrechts, De Bourdeaudhuij, Sjöström, Ruiz, Ortega, et al. (2011) showed that the IPAQ is equally able to predict cardiorespiratory fitness among adolescents as data from accelerometers. Following the IPAQ-guidelines (see www.ipaq.ki.se/scoring.pdf), daily PA values of 10 minutes or lower were set at 0, because it is assumed that daily PA values of 10 minutes or lower have no impact on health. Moreover, reports of daily PA higher than 180 minutes/day were limited to 180min/day, leading to a maximum moderate or vigorous weekly PA of 21h.

Subjective sleep/sleep disturbance

The Insomnia Severity Index (ISI; Bastien, Vallières, & Morin, 2001) is a 7-item screening measure for insomnia and an outcome measure for use in treatment research. The items, answered on 5-point rating scales (0=not at all, 4=very much), refer in part to DSM-IV (Diagnostic and Statistical Manual of Mental Disorders) criteria for insomnia (American Psychiatric Association, 2000) by measuring difficulty in falling asleep, difficulties remaining asleep, early morning awakenings, increased daytime sleepiness, impaired daytime sleepiness, impaired daytime performance, low satisfaction with sleep, and worrying about sleep. The higher the overall score, the more the respondent is assumed to suffer from sleep disturbances (Cronbach's alpha=.92). Note that we used the terms subjective sleep (sS) and sleep disturbances interchangeably.

Statistical analysis

To calculate the association between age, MT, QOL, sleep and PA, correlational computations were performed. To compare MTQ48 subcomponents between female and male participants, a series of t-tests was performed. Next, the MTQ48 overall score was categorized into the variable MT group of four groups based on percentiles of <25%, 25-50%, 50-75% and 75-100%. A series of ANCOVAs with Gender and the variable MT group as independent factors, and sleep, PA and **QoL** as dependent variables (with Age as covariate). Post-hoc analyses were calculated with the Bonferroni-Holm correction for p-values. To explore to which extent a global health-related **QoL** is predicted by MT, PA and sleep, a multiple regression analysis (stepwise exclusion) was performed. The level of significance was set at alpha = .05. Statistics was performed with SPSS® 20.0 (IMB Corporation, Armonk NY, USA).

Results

Correlative associations between mental toughness (MT), physical activity (PA), subjective sleep (sS) and quality of life (QoL)

Table 2 provides the descriptive statistics and correlations (Pearson's correlations) between the five TM scales and variables related to demographics (age, gender, BMI), physical activity (PA), sleep and quality of life (QoL)

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Table 2

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Greater MT (subcomponents and overall score) was significantly associated with male gender, lower sleep disturbances and greater **QoL** (subcomponents and Global health-related quality of life index). MT (subcomponents and overall score) was not significantly associated with age, BMI and moderate and vigorous PA.

During early and mid-adolescence, greater mental toughness is related to increased sleep quality and quality of life

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Differences in MT scores (subcomponents and overall score) between female and male participants

Compared to male participants, female participants reported significantly lower scores in MTQ48 subcomponents and in the MTQ overall score (challenge: f: $M = 2.95$, $SD = 0.85$; m: $M = 3.10$, $SD = 0.88$; $t(1473) = 2.39$, $p < .001$; commitment: f: $M = 3.12$, $SD = 0.63$; m: $M = 3.33$, $SD = 0.63$; $t(1473) = 3.48$, $p < .001$; control: f: $M = 3.05$, $SD = 0.56$; m: $M = 3.22$, $SD = 0.55$; $t(1473) = 5.72$, $p < .001$; confidence: f: $M = 3.02$, $SD = 0.69$; m: $M = 3.43$, $SD = 0.37$; $t(1473) = 4.98$, $p < .001$; MTQ48 overall score: f: $M = 3.11$, $SD = 0.49$; m: $M = 3.32$, $SD = 0.47$; $t(1473) = 4.79$, $p < .001$.

Differences in physical activity (PA), subjective sleep (sS) and ***quality of life (QoL)*** *as a function of gender and MT groups*

Table 3a and 3b provide the descriptive and inferential statistical overview of PA (moderate and vigorous), sS and **QoL**, separately for gender and MT groups.

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Table 3a and b

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To further investigate associations between MT, sS and PA, subjects were also divided into quartile groups according to their MTQ48 overall scores (from the lowest, quartile 1, to the highest, quartile 4) The MTQ48 overall score was divided into four MT subgroups to study if the sleep disturbance, PA and **(QoL)** means scores changed with the level of MT, or if

the mean scores of sleep disturbance, PA and **(QoL)** were different only between high and low MT sub-groups.

When PA, sS and **(QoL)** are considered between gender and MT groups, compared to females, male participants reported significantly higher moderate and vigorous PA, lower sleep disturbances, and increased physical and psychological well-being, and increased scores in relationships to parents and autonomy.

For MT groups, except for moderate and vigorous PA, where no significant MT group differences were observed, sleep disturbances decreased and QOL increased from 'Low MT group' to 'High MT group'.

Significant MT group x Gender interactions were found for sleep disturbances (Figure 1a), psychological well-being (Figure 1b),and social acceptance (Figure 1c), sleep disturbances decreased from 'Low MT' to 'High MT group'; females reported greater sleep disturbances, though sleep disturbances were lower in females of the 'Rather high MT group', compared to males of the 'Rather high MT group'. Psychological well-being increased from 'Low MT' to 'High MT group'; compared to male participants, female participants reported a higher increase in psychological well-being from 'Low MT' to 'High MT group'. In females, social acceptance changed in an inverted U-shaped manner from 'Low MT' to 'High MT group'; in males, social acceptance increased from 'Low MT' to 'High MT group'. **However, we note that effect sizes were small.**

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Figures 1a-1c

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Predicting global health-related quality of life

To predict global health-related quality of life as the composite score of the dimensions of quality of life questionnaire (KID-SCREEN-52), a multiple regression analysis was performed with global health-related quality of life index as dependent variable, and MT, sS and PA as independent variables. The global health-related quality of life index was predicted ($F(3, 1471)= 23.91$, $p < .000$; $R2 = .31$) by greater MT (MT Challenge: $\beta = .185$, $p < .000$; MT Commitment: $\beta = .21$, $p < .001$; MT Control, $\beta = .07$, $p = .004$) and lower sleep disturbances ($\beta = -.21, p < .001$), whereas PA (moderate; vigorous) and MT Confidence were excluded from the equation.

Discussion

The key findings of the present study are that among 11 to 16 years old adolescents mental toughness (MT) is related to male gender, to greater **quality of life (QoL)** and to lower sleep disturbances. Against our expectations, MT is not associated with physical activity.

Based on previous research (Brand, et al., 2014a,b; Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013) we hypothesized that greater MT was associated with increased PA, decreased sleep disturbances and greater **quality of life (QoL)**, however, data did not fully support these assumptions. Greater MT was associated with greater **QoL**: This pattern of results fits very well with previous findings on research in older adolescents and young adults (Gerber, et al., 2012; Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013). The present data therefore add to the current literature in that MT was assessed for the first time among early and mid-adolescents, and in that also among these adolescents, MT was associated with facets of **QoL**, as assessed via self-reports with the Kidscreen 52 (Ravens-Sieberer, et al., 2008), a tool assessing a broad variety of adolescents' concerns ranging from physical well-being, peer and parents relationships, to school environment. Moreover, results from the multiple

regression analysis showed that the global health-related quality of life index was best predicted by greater MT scores and low sleep disturbances.

Greater MT was associated with lower sleep disturbances: This pattern of results was also in accord with previous research: We found that among late adolescents greater MT was associated with both increased subjective (Brand et al., 2014a) and objective sleep (Brand et al., 2014b). How to explain this association? Research has established links between MT and hardiness, which has previously been found to be associated with stress resilience, and this observation is in accord with the idea that resilience does not evolve from avoidance of adversity, but from successful dealing with negative stimuli (Rutter, 1993). In this respect, though highly speculative and not provable with the present data, we hypothesize that MT influences sleep positively via reduced stress (Gerber, et al., 2012; Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013), reduced hyperarousal (Rieman, Spiegelhalder, Feige, Voderholzer, Berger, Perlis, et al., 2010), and reduced dysfunctional thoughts (Carney, & Edinger, 2006; Harvey, 2000, 2002). Accordingly, it is highly plausible that dysfunctional thoughts and maladaptive behavior are incompatible with the dispositions towards appraisal of high control, challenge, and commitment, that characterize a mentally tough person.

Next, we predicted more unfavorable MT scores in female as compared to male participants, and data did confirm this assumption. However, the study design does not allow an in-depth understanding of the underlying mechanisms as to why females, compared to males, report lower MT and **QoL**. We follow Hyde, Mezulis, and Abramson (2008): The authors propose that, specifically, depressive disorders are more often observed in female as compared to male adolescents as a function of affective (emotional reactivity), biological (genetic vulnerability, pubertal hormones, pubertal timing and development) and cognitive (cognitive style, objectified body consciousness, rumination) factors. Along with the interaction with negative life events, these affective, biological and cognitive factors may confer to an increased risk for depressive symptoms. Accordingly, though highly speculative,

we claim that these affective, biological, cognitive and environmental factors lead to lower self-reported MT scores in female as compared to male adolescents.

Against expectations and therefore at odds with previous research (Gerber, et al., 2012, Gerber, Brand et al., 2013, Gerber, Kalak et al., 2013), MT was *not* associated with PA, and PA was also not a predictor of the global health-related quality of life index. These findings do not mirror the wealth of studies showing a tight association between physical functioning, **QoL** and PA (Biddle, & Murtrie, 2007; Josefsson, Lindwall, & Archer, 2014; Silveira, Moraes, & Oliveira, 2013). We might suppose that the assessment tool (IPAQ) was inadequate to assess PA in this age group, or that items were incorrectly completed; however, the tool is well-established to assess adequately PA among adolescents and adults. Moreover, to complete the entire questionnaire, professional staff members were present in the classes and instructed thoroughly by means of examples on how to complete the IPAQ items. However, it remains possible that some participants over- and underestimated their weekly frequency and intensity of PA. We also note that standard deviations are high (see Table 3), suggesting therefore a very broad range of self-reported PA within and between the groups. Accordingly, significant mean differences were unlikely. Further, perhaps one reason for the discrepant results from other studies is that either MT is a different construct in younger adolescents or at least that the MTQ48 does not function equivalently in the younger and older adolescents. Last, we claim that further latent, though unassessed psychological dimensions might have blurred the association between PA, MT and **(QoL)**.

Despite the clarity of the findings and the large sample size, several considerations warrant against overgeneralization. First, we fully relied on self-report and not on experts' reports; accordingly, systematic rating biases are possible. Future research should also include experts' ratings. Second, sleep was only subjectively assessed, and again, it is possible that the correlation between MT and sleep primarily reflects an association between youth who see themselves as mentally tough and a tendency to see themselves as good sleepers, rather than

any real relationship between sleep and MT. Third, pubertal stage was not assessed, and, accordingly, underlying hormonal and neuroendocrine processes might have biased the present pattern of results. Fourth, objective PA analysis might have conferred to a more reliable assessment of PA. **Fifth, effect sizes were small; therefore statistically significant mean differences should not be overestimated. Sixth, the present pattern of results might have emerged due to a latent third variable causing the measured variables to change in the same direction.** Last, the cross-sectional design does not allow any conclusion as to the causal direction of the pattern of association.

Conclusions

In a larger sample of participants of early and mid-adolescence, we found that MT was associated with increased sleep quality and greater **QoL**. Against expectations, MT was not associated with PA, suggesting that in this age group the association between PA, MT and **(QoL)** might be more complex as generally assumed.

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Conflicts of interest

All authors declare no conflict of interests.

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