

**Chronotype assessment of the Bengalese adolescents: an observational study using a Bengali version of the reduced Morningness-Eveningness Questionnaire (rMEQ)**

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**Running head:** Circadian typology of Bengalese Adolescents.

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**Abstract**

Chronotype or morningness orientation is an interpersonal characteristic which is known to influence human physiology and psychology and less is known about the chronotype of the Bengalese adolescents in India. We aimed to study the chronotype of this population by using a translated version of a previously established questionnaire. For that, 471 Bengali-speaking adolescents (13-14 years) (boys=268, girls=203) of West Bengal, India were included in this study and their chronotype was assessed using an interviewer-administered Bengali version of the reduced Morningness-Eveningness Questionnaire (rMEQ). The reliability of the translated instrument was assessed using Cronbach's  $\alpha$ . The chi-squared test was used to observe the distribution patterns between the boys and girls. The rMEQ scores of all the participants ranged between 5 and 25 with a median value of 17 (25<sup>th</sup>-75<sup>th</sup> percentile: 15-20). The Cronbach's  $\alpha$  of the Bengali version was 0.751. Using cut off scores, we found 47% of our study participants were of morning chronotype, whereas the intermediate and evening types were of 50% and 3%, respectively. Chi-squared test demonstrated a significantly higher morningness among boys than the girls. The study describes the morningness orientation pattern of the Bengalese adolescents that may have some defined influence on their physiological and psychological characteristics including health and disease.

**Keywords:** Morningness-Eveningness Questionnaire, Bengali version, chronotype, adolescents, gender.

## 1. Introduction

Circadian biology deals with endogenously generated self-sustaining rhythm which controls physiological functions, biochemical synthesis, secretions and behavioural variables (Juda 2010). Chronotype (CT) is defined as the personal preference of sleep-wakefulness and activity timing and is a well-defined psycho-behavioural characteristic standardised with physiological and psychological measures (Adan et al. 2012). This interpersonal characteristic describes people with different sleep-wake phase, such as morningness means early sleeping at night and early rise in the morning whereas eveningness proposes late sleeping at night and late waking up in the morning (Taillard et al. 2001; Ferraz et al. 2008; Adan et al. 2012). Several reports described the links between chronotype and several social, psychological, behavioural and clinical manifestations (Mecacci & Rocchetti 1998; Hidalgo & Caumo 2002; Wyatt et al. 2006; Goldstein et al. 2007; Randler 2008a; Randler 2008b; Randler 2008c; Adan et al. 2010; Loureiro & Garcia-Marques 2015; Sundar et al. 2015; Moitra et al. 2018). Therefore, chronotyping might be helpful in better understanding of the connection between circadian rhythm, physical and mental performance and disease.

Several self-assessment questionnaires have been used internationally to determine the chronotype of an individual (Horne & Östberg 1976; Folkard et al. 1979; Torsvall & Åkerstedt 1980; Smith et al. 1989; Smith et al. 2002; Di Millia et al. 2005) and are well validated by subjects' physiological rhythms (e.g. melatonin, cortisol, or body temperature) in several countries (Duffy et al. 1999, 2001; Bailey & Heitkemper 2001; Adan et al. 2012). A quantitative chronotype questionnaire (Roenneberg et al. 2003) has also been developed that assesses sleep and activity times separately for work and free days and has been validated against the MEQ (Zavada et al. 2005; Adan et al. 2012). Based on the scoring of the abovementioned

questionnaires CT can be divided into morning type (early riser, go to bed early, physically and mentally morning active), evening type (late riser, go to bed late, physically and mentally evening active) and intermediate type (in between the former two types).

Considering the limitations of original MEQ developed by Horne and Östberg (1976) such as limited reliability, heterogeneity in the morning cut-off score (Rahafar et al. 2015) and time-consuming nature (Randler 2013), Adan and Almirall (1991) developed the reduced version of morningness-eveningness scale (rMEQ), a 5-item scale that constituted items 1, 7, 10, 18 and 19 from original MEQ. rMEQ asks participants about their preferred wake up time (rMEQ1), the degree of tiredness during first half hour after wake up in the morning (rMEQ2), sleep time at night (rMEQ3), peak personal efficiency time (rMEQ4) and self-estimation of chronotype (rMEQ5). Despite its several limitations such as assumption-based question (e.g. “approximately what time would you get up if you were entirely free to plan your day?”) (Terman et al. 2001), different cut off scores (Di Milia et al. 2013) and questionable consistency (Di Milia et al. 2013), it has also been established to be a reliable measure with acceptable psychometric properties and convergent validity (Adan & Almirall 1991; Caci et al. 2009; Tonetti et al. 2012; Randler 2013; Rahafar et al. 2015). Moreover, rMEQ is particularly useful in large-scale epidemiological studies, especially those with multiple dimensions where large questionnaires are impossible to administer (Jankowski 2013).

Studies regarding chronotype distribution among adolescents suggested higher evening types with delayed sleep timing in boys than girls (Randler 2007, 2013; Tonetti et al. 2008; Borisenkov et al. 2010, 2012). Unlike those European studies, there are only a few reports on chronotype pattern of the Indian adolescents which established the predominance of morning type (Pande et al. 2018) or neither type (Achari & Pati 2007). These reports represented the

characteristics of the local population and merely provide a general consensus of Indian population. Also, taking into account the fact that chronotypological variation is associated with several psychosocial and behavioural characteristics (such as food and sleep pattern, performance and activity, mental stability and social interactions) (Inderkum & Tarokh 2018; Anderson et al. 2018; Park et al. 2018), academic performance (Randler & Frech 2006; Vollmer et al. 2013) and clinical manifestations (such as asthma response, cardiovascular health and cancer) (Dickerman et al. 2016; Adams et al. 2017; Durrington et al. 2018; Moitra et al. 2018; Hulsegge et al. 2018), it becomes important to study the chronotype of different population separately in a large country like India with huge variation in geographical location, social and cultural practice. In this study, we aimed at investigating the chronotype of the Bengalese adolescents using a Bengali version of the rMEQ.

## **2. Methods and Materials**

### **2.1 Translation and adaptation of the instrument**

In this study, we used a Bengali version of the reduced morningness-eveningness questionnaire (rMEQ) to assess the chronotype of Bengalese adolescents. The rMEQ is a 5-item reduced version of the morningness-eveningness questionnaire (MEQ) (Horne & Östberg 1976; Adan & Almirall 1991), based on which the participants are categorized into different chronotypes. Each question of the instrument contains multiple choice answer options and the participants are asked to mark the option that best reflects their personal feeling. The score/weight allotted to the options of each of the questions is different which generate a cumulative score ranging between 4 and 25 based on which the chronotype of an individual is identified (morning chronotype: >17; intermediate chronotype: scores between 12 and 17; and evening chronotype: <12) (Adan & Almirall 1991).

The rMEQ was translated into Bengali by two native speakers with demonstrated bilingual proficiency (both in English and Bengali) and their identities were kept blinded to each other to observe any ambiguity in the translations. A third translator with similar bilingual proficiency back-translated the Bengali version to English and the Bengali version that demonstrated the closest similarity to the main questionnaire upon translation was adapted for use in this study. Some terms like ‘morning type’ and ‘evening type’ were kept the same in the Bengali version as it was in the English rMEQ.

## **2.2 Participants**

Based on an *a priori* evidence of the minimum inter-item correlation coefficient of 0.194 between two items of the rMEQ questionnaires (Loureiro & Garcia-Marques, 2015), and with an alpha risk of 0.05 and a beta-risk of 0.20 in a two-sided test, and assuming a 15% non-response rate, we randomly selected 486 Bengali-speaking adolescent (aged between 13 and 14 years) students from the Prevalence and Risk Factors of Asthma and Allergy-Related Diseases among Adolescents (PERFORMANCE) Study pool. The selection and recruitment criteria of the participants in the main study have been described elsewhere (Bhattacharjee et al. 2018). However, we observed only 3% non-responsiveness and finally selected a total of 471 adolescents (male=268, female=203). The questionnaire was given to all the participants and they were asked to mark the option that best reflected their personal feeling.

The study has been ethically approved by the Clinical Research Ethics Committee of the Allergy & Asthma Research Centre (CREC-AARC), Kolkata and followed the tenets of the declaration of Helsinki and the guidelines for chronobiological studies (Portaluppi et al. 2010). As the participants were minors, signed informed consents were obtained from their parents. In

cases where parents were illiterate, the heads of the schools provided the informed consents on behalf of the parents.

### **2.3 Statistical analyses**

rMEQ item scores were treated as continuous variables and/or count variables as found appropriate for the downstream analyses. The distribution of the rMEQ scores among the participants was presented as median (25th-75th percentile). We tested the reliability of the translated version of the questionnaire using Cronbach's  $\alpha$ . We used Pearson's correlation to test the association between the items of the questionnaire among all the participants and stratified by gender. We used the dimension reduction technique (principal component analysis) of the questionnaire items to seek information of the major component(s) which represent(s) the maximum variance within the questionnaire instrument. We considered the tests significant if the p-value was smaller than 0.05. All analyses were performed in the Statistical Package for the Social Sciences (SPSS) version 22 (IBM Corp., Armonk, NY, USA).

### **3. Results**

The translated version of the rMEQ along with its English counterpart is presented in Appendix 1. Cronbach's  $\alpha$  of the Bengali version of rMEQ was found 0.751 for the entire study population. The reliability of the version enhanced when tested among the girls (Cronbach's  $\alpha$ = 0.762) compared to the boys (0.731) (data not shown), however, the values were found to be consistent and were higher than the minimum acceptable value of 0.7.

The inter-item correlation of the rMEQ showed high association ( $p < 0.05$ ) between the items of the questionnaire (Table 1). The principal component analysis of the rMEQ items yielded a single component with the maximum variance (Eigenvalue= 3.08, % of variance=

51.374) (Table 2) demonstrating a single factor solution for the entire questionnaire to identify the chronotype of a person.

Insert Table 1

Insert Table 2

The distribution of the participants based on their different chronotypes was presented in Table 3. It was observed that 50% of the Bengalese adolescents were an intermediate type, 47% were morning type and only a little fraction (3%) follows evening pattern. After stratifying by gender, boys were found to be more morning-type than the girls (53 vs. 39%,  $p=0.006$ ) while girls were more of the intermediate chronotype (58 vs. 45%,  $p=0.006$ ).

Insert Table 3

#### **4. Discussion**

We demonstrate that the Bengali version of the rMEQ has an acceptable reliability index and similarities with other versions (Chelminsky et al. 2000; Caci et al. 2009; Carciofo et al. 2012; Randler 2013; Rahafar et al. 2015). Dimension reduction technique also demonstrated the rMEQ coherent to the other versions of the rMEQ (Jankowski 2013; Randler 2013; Rahafar et al. 2015).

We observed that the majority of the Bengalese adolescents belonged to intermediate chronotypes with higher proportion of morning larks over the evening owls. The present observations are reciprocated to the previously reported Indian study (Smith et al. 2002; Achari & Pati 2007; Nag & Pradhan 2012; Tonetti et al. 2012; Randler et al. 2015; Pande et al. 2018) with one exception of significant higher morning type in boys than the girls. The higher percentage of morning chronotype can be linked to sunrise timing (early sunrise), environmental

temperature and cultural aspects (Smith et al. 2002; Tonetti et al. 2012; Randler et al. 2015) of India but significant higher morningness among boys than the girls is somewhat unexpected. All the above-mentioned studies among Indian populations were performed on either adult sample or a much larger age range than that of us (age range: 13-14 years) which might contribute significantly to such unexpected findings. It is well-established that the morning people are more conscientious and agreeable, have higher persistence and self-directedness, achieved higher academic scores and overall are more satisfied with their lives comparing to their counterparts (Randler & Frech 2006; Randler 2008a; Randler 2008b; Adan et al. 2010; Vollmer et al. 2013; Loureiro and Garcia-Marques 2015). Considering different lifestyle of different chronotypes of people, MT seems to be a protection factor than ET for psychiatric conditions, especially restlessness, rapid mood swing and depression. MT exhibits healthier habits than their counterparts which are particularly very crucial for adolescents as they are on the verge of their adulthood (Adan et al. 2012). We found only 2.6% of our study population as evening chronotype which was in line with the findings of Achari and Pati (2007) (only 1.93% was found to be evening chronotype), the plausible explanations can be drawn as firstly, lower individualism of Indian population (Tonetti et al. 2007) interrupt with the personal choices of Indian adolescents. Secondly, Most of the Indian parents impose an 'early to bed and early to rise' practice on their children and prohibit them from any late-night activities (Pande et al. 2018).

There are several limitations in this study such as absence of sleep-wake variables, inability to perform any objective measurement, narrow age range of participants etc. Since the data were obtained from the school-going adolescents, we believe that the self-reported responses were unbiased as described previously (Di Milia et al. 2008; Di Milia & Muller 2012).

However, at the same time, we also believe that additional information including sleep-wake variables and objective measurements like melatonin secretion and actigraphy would have supported our observation better.

We may conclude that for the first time, we assessed the chronotype of the Bengalese adolescents by using a Bengali version of the rMEQ. Majority of the Bengalese adolescents were found to be intermediate type with higher proportion of morning larks over the evening owls although the explanation of such orientation needs further studies in this domain. The Bengali version has an acceptable reliability and can be used as a reference standard for this population.

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**Table 1:** Inter-Item correlation matrix of the rMEQ instrument

	<b>Item 1</b>	<b>Item 2</b>	<b>Item 3</b>	<b>Item 4</b>	<b>Item 5</b>
<b>Item 1</b>	1				
<b>Item 2</b>	0.30*	1			
<b>Item 3</b>	0.28*	0.10*	1		
<b>Item 4</b>	0.21*	0.08	0.03	1	
<b>Item 5</b>	0.64*	0.25*	0.23*	0.35*	1

Data presented as Pearson's correlation coefficient ( $r$ ). \*indicates the coefficients significant at  $p < 0.05$ .

**Table 2:** Principal component analysis of the rMEQ instrument

	<b>Loading factor</b>	<b>Eigenvalue</b>	<b>% of variance</b>	<b>Cumulative %</b>
<b>Item 1</b>	0.812	3.082	51.374	51.374
<b>Item 2</b>	0.496	0.987	16.456	67.830
<b>Item 3</b>	0.471	0.896	14.933	82.763
<b>Item 4</b>	0.498	0.692	11.532	94.195
<b>Item 5</b>	0.844	0.342	5.705	100

Loading factors were obtained from the component matrix of the principal component analysis.

Rotation could not be estimated due to single component extraction.

**Table 3:** Distribution of the participants based on different chronotypes

<b>Chronotype</b>	<b>All participants (n=471)</b>	<b>Boys (n=268)</b>	<b>Girls (n=203)</b>	<b>P value</b>
Morning (>17)	221 (46.9%)	141 (52.6)	80 (39.4)	0.006
Intermediate (12-17)	238 (50.3)	120 (44.8)	118 (58.1)	0.006
Evening (<12)	12 (2.6)	7 (2.6)	5 (2.5)	0.92

Data presented as frequency (%) unless otherwise indicated. P values were calculated from chi-squared tests between the Boys and Girls.