Contents lists available at ScienceDirect

European Psychiatry

Review

Measures of circadian preference in childhood and adolescence: A review

L. Tonetti [a,*], A. Adan [b,c], L. Di Milia [d], C. Randler [e], V. Natale [a]

[a] Department of Psychology, University of Bologna, Viale Berti Pichat 5, 40127 Bologna, Italy
[b] Department of Psychiatry and Clinical Psychobiology, School of Psychology, University of Barcelona, 08035 Barcelona, Spain
[c] Institute for Brain, Cognition and Behavior (IR3C), 08035 Barcelona, Spain
[d] School of Management and Institute for Health and Social Science Research, Central Queensland University, QLD 4702 Rockhampton, Australia
[e] Department of Biology, University of Education, 69121 Heidelberg, Germany

ARTICLE INFO

ABSTRACT

Purpose: To review the psychometric properties of the questionnaires commonly filled in by children and adolescents to measure circadian preference.

Methods: We examined the Morningness-Eveningness Questionnaire for Children and Adolescents (MEQ-CA), the Morningness-Eveningness Scale for Children (MESC) and the Composite Scale of Morningness (CSM). We critically analyzed the reliability, in term of internal consistency (through the Cronbach's alpha) and test-retest reliability (through the correlation coefficient), and the type of validation against external criteria (objective assessment of the sleep/wake cycle, body temperature, hormones and other questionnaires). Fifty studies that reported these data were included in the review: 7 studies used the MEQ-CA, 28 used the MESC and 15 used the CSM.

Results: The percentage of studies reporting at least acceptable levels of internal consistency was high and similar between the three questionnaires. Evidence for test-retest reliability was scant, since only 3 studies were available; it was at least acceptable for the MESC (two studies with a time interval of 1 month), not acceptable for the MEQ-CA (one study with a time interval of 6 months), while no information was available for the CSM. As regards the validation evidence, the MEQ-CA has been validated by the highest number of external criteria (actigraphy, oral body temperature and other questionnaires), followed by the CSM (cortisol sampling and other questionnaires). The MESC has been validated only against self-report measures.

Conclusions: The present state of the art would suggest the use of the MEQ-CA to assess circadian preference in children and adolescents.

1. Introduction

The concept of circadian preference refers to one of the most marked inter-individual differences in the expression of human circadian rhythms. Circadian preference may be conceived as a continuum [41] between two extremes: morning types (MTs, also called "larks") and evening types (ETs, also called "owls"). MTs usually report an early bedtime, rise time and they perform better in the morning, while ETs report later bedtimes, rise times and they perform best later in the day. Intermediate types (ITs, also called "neither") are those who fall within the two extremes of this continuum and represent the majority of the population.

To date, four major reviews [2,15,36,71] have summarized the results of the main studies that investigate circadian preference. In brief, those reviews have shown that ETs show a delayed circadian phase compared to MTs and that chronotypes have different socio-demographic, personality, cognitive and genetic characteristics. Circadian preference also varies according to latitude and longitude, in both adults [2] and adolescents [52].

As regards the measuring of circadian preference, there are some biological markers (e.g., body temperature, cortisol, melatonin and the sleep-wake cycle) that are used to identify differences between MT, IT and ET [2]. Even if these methodologies are very reliable, they are also expensive and usually allow analyzing small samples. On the contrary, several self-report questionnaires, which allow measuring circadian preference at low cost in large samples size, have been developed and used in the last 38 years. Recently, Di Milia et al. [19] reviewed the psychometric properties of the

* Corresponding author. Tel.: +39 051 2091877; fax: +39 051 243086.
E-mail address: lorenzo.tonetti2@unibo.it (L. Tonetti).

questionnaires which are most commonly used to assess circadian preference in adult populations, in particular: the Morningness-Eveningness Questionnaire (MEQ) [32], the Composite Scale of Morningness (CSM) [68], the reduced Morningness-Eveningness Questionnaire (rMEQ) [1], the Preference Scale (PS) [69] and the Munich ChronoType Questionnaire (MCTQ) [63]. Di Milia et al. [19] reported that, overall, these measures had excellent levels of internal consistency and test-retest reliability; furthermore, these questionnaires had adequate convergent and construct validity. The authors concluded there was no *best* tool in absolute terms to measure circadian preference in adults; on the contrary, they suggested choosing the questionnaire according to the features and goals of the study in question.

To date, no review has assessed the psychometric properties of the most frequently used measures of circadian preference during childhood and adolescence. This lack of knowledge is severe if we keep in mind that a valid and reliable measurement is fundamental in any field of science and that the features of circadian preference are different between childhood and adolescence [2]. Indeed, during childhood, morningness preference is more prevalent than eveningness preference, with the intermediate typology being the most common. A number of studies employing subjects of different nationalities have suggested that from approximately 12–13 years of age there is a pronounced shift to an evening preference [14,29,35,74]. It is essential to use reliable and valid instruments that allow us to assess the features of these changes. This shift may be explained by both biological (e.g., pubertal maturation) [14] and psychosocial factors (e.g., use of electronic media) [11]. The relevance of an accurate measurement of circadian preference is of utmost importance if we bear in mind that eveningness has been detected as a risk factor, not only in adults but already in adolescents, for several health-impaired conditions including behavioral/emotional problems [30], substance abuse [31], internet addiction [60], eating disorders [66], high mood seasonality [75] and excessive diurnal sleepiness [29,76]. Furthermore, eveningness has also been identified as a risk factor for a decreased school performance [82]. The accurate assessment of circadian preference via the use of questionnaires as screening tools is also necessary, therefore, in order to detect high risk in adolescents regarding health-impairing behaviours and low school achievement.

While the first questionnaire for the assessment of circadian preference in adults, the MEQ, was developed in 1976 by Horne and Östberg [32], the need to develop a specific measure designed for children and adolescents was only felt between 1992 and 1993, when Carskadon et al. developed and validated the Morningness-Eveningness Scale for Children (MESC) [14]. The sixteen years' interval between the first circadian preference questionnaire for adults and that for children and adolescents demonstrates that the topic of circadian preference measurement during childhood and adolescence was, for a long while, neglected. It is only recently that interest in such assessment has considerably increased [2,65]. Thus the goal of this study is to review the psychometric properties of the questionnaires commonly filled in by children and adolescents to measure circadian preference.

2. Methods

2.1. Selection of studies

On November 14th, 2014 we performed four separate bibliographic searches using the Institute of Scientific Information (ISI) Web of Knowledge databases. We used the following keywords: (1) "eveningness, questionnaire, childhood"; (2) "eveningness, questionnaire, children"; (3) "eveningness, questionnaire, adolescence"; (4) "eveningness, questionnaire, adolescents".

2.2. Investigated parameters and exclusion criteria of studies

For the most commonly used measures, we collected from each study: the nationality of the samples, sample size, gender, age range, internal consistency (assessed through the Cronbach's α value) and test-retest reliability (assessed through the correlation coefficient), and evidence of validation with external criteria (i.e., objective assessment of the sleep/wake cycle, body temperature, hormones and other questionnaires). Internal consistency assesses if several items of the same questionnaire, that are intended to measure the same construct, determine similar scores. Internal consistency is usually assessed through the Cronbach's α statistic, which is a function of the number of the questionnaire items and the average inter-correlation between items. This coefficient is derived from a single administration of the questionnaire, with higher scores indicating a reliable measure. Cronbach's α values ≥ 0.70 are typically considered acceptable [44]. Test-retest reliability is an index of the consistency of the replies to the same scale at two different times. This kind of reliability is generally measured through a correlation coefficient, which is usually considered acceptable when greater than 0.75 [5]. The evidence of validation with external criteria refers to the concordance between the measure provided by the questionnaire with that of a criterion variable (objective or subjective) which is representative of the same construct.

We excluded studies investigating samples that were not composed of children and adolescents (according to the suggestion put forward by Roenneberg et al. [64], we considered individuals older than 20 years as adults), those which examined participants with health problems, studies that did not report the psychometric properties that we chose to investigate, and those in which the questionnaires were filled in by the parents. Moreover, in reporting Cronbach's alpha we excluded studies with samples containing fewer than around 200 participants and with test-retest values on samples of fewer than about 40. Furthermore, given the age-related changes in circadian preference [14,29,35,74], we excluded studies where the measures were completed more than six months apart.

The data of the present review were independently coded by two of the authors (LT and CR), and inter-rater agreement was 95%. When discrepancies occurred between them, they were resolved through discussion. The criteria for the coding of external validity variables were a-priori defined by the two coders on the basis of an earlier review of measures of circadian typology in adults [19].

Both coders looked for the psychometric properties and evidence of validation with external criteria in the records retrieved through the bibliographic searches, and they reported the data found, separately for each questionnaire, in the supplementary tables. Afterwards, the data regarding the psychometric proprieties and the evidence of validation with external criteria were synthesized for each questionnaire and were separately reported into two different tables (see Tables 1 and 2). When a study reported several psychometric properties of the same type on the same sample, for example in the case of longitudinal work carried out by Andrade et al. [4], we chose to report all the retrieved properties that satisfied our inclusion criteria in the supplementary tables.

3. Review of circadian preference measures

According to the guidelines of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Statement [39],