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NOCTURNAL MELATONIN LEVELS AT DIFFERENT GEOGRAPHICAL LATITUDES: A COMPARATIVE ANALYSIS WITH THE MID-LATITUDE POPULATION OF UZBEKISTAN

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Abstract

This study evaluated nocturnal salivary melatonin levels in a mid-latitude population of Uzbekistan and compared the observed pattern with published data from populations living at higher and lower geographical latitudes. The study included 200 apparently healthy individuals aged 6–69 years who were divided into five age groups. Nocturnal salivary melatonin concentrations were measured by enzyme-linked immunosorbent assay under standardized low-light conditions. A pronounced age-dependent decline in melatonin levels was observed, from 150.60±5.64 pg/mL in children aged 6–12 years to 19.47±3.50 pg/mL in participants aged ≥60 years ($F=192.7$; $p<0.001$). Comparative analysis with published international data suggested that the melatonin profile of the Uzbekistan population occupies an intermediate position between patterns reported at higher and lower geographical latitudes. This observation is consistent with the known influence of photoperiod on the timing, duration, and amplitude

of melatonin secretion. The findings indicate that geographical latitude, seasonal light exposure, and local photoperiodic conditions should be considered when interpreting nocturnal melatonin measurements. Region-specific reference values may therefore be more appropriate than direct application of reference ranges established in geographically distant populations.

Keywords: melatonin, salivary melatonin, geographical latitude, photoperiod, circadian rhythm, nocturnal secretion, Uzbekistan.

Background

Melatonin is a key neuroendocrine hormone involved in the synchronization of circadian rhythms with the environmental light–dark cycle. Its nocturnal secretion serves as an important internal signal of darkness and reflects the duration of the biological night [1,2]. The onset, duration, and amplitude of melatonin secretion are strongly influenced by photoperiod, and therefore by geographical latitude, season, and the length of natural daylight exposure. At higher geographical latitudes, where seasonal variations in day length are more pronounced, significant shifts in melatonin timing and secretion profiles have been reported, particularly between summer and winter periods [2–4]. In contrast, populations living at lower latitudes are generally exposed to smaller seasonal fluctuations in photoperiod, which may result in less pronounced seasonal changes in melatonin rhythms.

Geographical and environmental conditions may therefore contribute to interpopulation differences in nocturnal melatonin concentrations and circadian organization. However, the majority of available data have been obtained from European, North American, and northern Eurasian populations, while evidence from Central Asia remains relatively scarce. Uzbekistan is located at mid-

latitudes and has a continental climate with marked seasonal differences in daylight duration. Investigation of nocturnal melatonin secretion in this population may provide additional information on the possible relationship between geographical latitude, photoperiod, and circadian endocrine regulation.

Objective

To evaluate the characteristics of nocturnal salivary melatonin secretion in the mid-latitude population of Uzbekistan and to compare the obtained values with published data from populations residing at higher and lower geographical latitudes.

Materials and Methods

The Uzbekistan cohort included 200 apparently healthy individuals aged 6–69 years. Participants were divided into five age groups: 6–12 years (n=40), 13–18 years (n=42), 19–44 years (n=38), 45–59 years (n=40), and ≥60 years (n=40). Saliva samples were collected during the nocturnal period under standardized low-light conditions in order to minimize the suppressive effect of artificial light exposure on melatonin production.

Nocturnal salivary melatonin concentration was measured using enzyme-linked immunosorbent assay (ELISA). Descriptive statistical analysis was performed for each age category, and differences between age groups were evaluated using one-way analysis of variance (ANOVA).

For the geographical comparison, the obtained data were compared with published results from studies conducted in populations living at higher and lower latitudes. Interpretation of international data was performed with consideration of potential methodological differences, including the timing of biological sample collection, season of examination, type of biological material, assay

methodology, participant age structure, and environmental light conditions. Because the comparative component was based on published literature rather than a single standardized multicenter protocol, the findings were interpreted as comparative observational evidence rather than direct interpopulation measurements.

Results

In the mid-latitude population of Uzbekistan, nocturnal salivary melatonin concentrations demonstrated a pronounced age-dependent decline. The highest mean level was observed in children aged 6–12 years and amounted to 150.60±5.64 pg/mL. In adolescents aged 13–18 years, the mean concentration decreased to 122.13±7.98 pg/mL, while in adults aged 19–44 years it was 94.96±7.66 pg/mL. A further reduction was observed in the 45–59-year age group, in which the mean melatonin concentration was 53.98±4.14 pg/mL. The lowest mean value, 19.47±3.50 pg/mL, was recorded in participants aged ≥60 years. Differences among the age groups were highly statistically significant ($F=192.7$; $p<0.001$).

Comparison with published international studies indicated that the nocturnal melatonin profile observed in Uzbekistan generally occupied an intermediate position between patterns reported in populations living at higher and lower geographical latitudes. Studies from northern regions have demonstrated more pronounced seasonal changes in melatonin secretion, including changes in the phase, duration, and in some cases amplitude of nocturnal melatonin production. These observations are consistent with experimental findings showing that exposure to shorter photoperiods may prolong the duration of nocturnal melatonin secretion [2,3].

Field studies performed at approximately 55–60°N have also demonstrated seasonal shifts in melatonin timing associated with substantial differences in natural daylight exposure between winter and summer [3,4]. By comparison, populations residing closer to the equator are exposed to relatively stable day length throughout the year, potentially resulting in smaller photoperiod-related variations in circadian melatonin rhythms.

The pattern observed in the Uzbekistan cohort is therefore biologically plausible for a mid-latitude population exposed to moderate but clearly expressed seasonal variation in photoperiod. At the same time, age remained a major determinant of nocturnal melatonin concentration, indicating that both geographical and physiological factors should be taken into account when interpreting melatonin measurements.

Discussion

The present findings support the concept that geographical latitude and associated changes in photoperiod may contribute to variability in human nocturnal melatonin secretion. Uzbekistan occupies an intermediate geographical position relative to high-latitude northern populations and low-latitude regions, and the observed melatonin profile appears generally consistent with this geographical setting.

The relationship between latitude and melatonin is likely mediated primarily through differences in natural light exposure. Melatonin synthesis is highly sensitive to retinal light input and the activity of the suprachiasmatic nucleus, which coordinates circadian timing. Longer nights and shorter photoperiods may extend the duration of nocturnal melatonin secretion, whereas prolonged daylight exposure can delay its onset or shorten the biological night. Consequently,

populations living under markedly different photoperiodic conditions may demonstrate different circadian melatonin profiles even in the absence of disease. However, geographical latitude alone cannot fully explain interpopulation differences. Seasonal timing of sampling, artificial light exposure, sleep schedules, lifestyle, occupational patterns, age distribution, and analytical methodology may all substantially influence measured melatonin concentrations. This is especially important when comparing results from different published studies, because direct numerical comparison may be limited by methodological heterogeneity.

The pronounced age-related decline observed in the Uzbekistan cohort further demonstrates that demographic characteristics must be considered together with geographical factors. Therefore, the use of universal reference ranges derived from populations living at substantially different latitudes may be inappropriate. Region-specific and age-specific reference values may provide a more accurate basis for interpretation in both clinical and research settings.

The present comparative analysis should be regarded as an initial step toward a more comprehensive evaluation of circadian endocrine characteristics in Central Asian populations. Future multicenter studies using identical sampling times, standardized dim-light conditions, harmonized analytical methods, and seasonal repeated measurements would allow a more reliable assessment of the independent effects of latitude and photoperiod on nocturnal melatonin secretion.

Conclusion

Nocturnal salivary melatonin concentrations in the mid-latitude population of Uzbekistan demonstrate a pronounced age-dependent decline and, in comparison with published international data, appear to occupy an intermediate position between patterns reported at higher and lower geographical latitudes. These

findings suggest that geographical latitude, photoperiod, age, and environmental light exposure should be considered when interpreting melatonin measurements. The results support the rationale for developing region-specific and age-adapted reference values rather than directly extrapolating data obtained from geographically distant populations. Further standardized multicenter and seasonal studies are required to confirm and quantify latitude-related differences in melatonin secretion.

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