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Impact of sleep disordered breathing on performance in judo players

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ABSTRACT

Objective Previous studies have suggested that young sports players may suffer from sleep disordered breathing (SDB). It was hypothesised that SDB in heavy-class judo players was far more prevalent than expected and that it could reduce judo performance, which could be improved by appropriate therapies. To address this, the present study estimated the percentage of heavy-class judo players with SDB and investigated the effect of SDB treatment on judo performance.

Methods We enrolled 19 young judo players from a university judo team with body weight >100 kg and/or body mass index >30 kg/m^2. Both excessive daytime sleepiness (EDS) and respiratory disturbance index (RDI) were evaluated using the Epworth Sleepiness Scale (ESS) and an overnight type 3 sleep monitor.

Results The percentages of young heavyweight-class judo players with EDS (ESS ≥11) and those with SDB (RDI ≥5) were both 63%, which was unexpectedly high for the age class. Seven of the participants underwent continuous positive airway pressure therapy, which improved both RDI and ESS scores ($p<0.05$ for each) and subsequently the sleep quality and judo performance of the participants.

Conclusions Our study indicates that young judo players might silently suffer from SDB, leading to poorer judo performance and to future cardiovascular diseases. Clinicians should be aware of the possible presence of SDB in young sports players and consider the application of diagnostic and therapeutic remedies.

Key messages

- Sleep disordered breathing is highly prevalent in judo players.
- Sleep disordered breathing reduces judo performance.
- Appropriate treatment of sleep disordered breathing improves judo performance.

INTRODUCTION

Obstructive sleep apnoea (OSA), a condition arising from repeated events of airway closure and opening during sleep, is a major but treatable cause of sleep disordered breathing (SDB). SDB is a current medical and social issue because it can lead to future cardiovascular disease[1] and mistakes and injury in the workplace, such as traffic accidents.[2–5] Furthermore, SDB is highly prevalent in the general population and thus is regarded as a common disease. In a previously published population-based study, the prevalence of SDB in men in their 30s and 50s was 7.9%–17.0% and 19.7%–31.0%, respectively.[6–8] Continuous positive airway pressure (CPAP) is one of the therapeutic options for SDB, and can remedy excessive daytime sleepiness (EDS) and improve cognitive functions,[9–11] as well as reduce the risk for cardiovascular diseases associated with SDB.[12–14]

SDB also affects vigilance and judgement ability of sports players, although data in this regard are limited. In a study of golfers, SDB reduced performance, while an appropriate therapeutic approach, that is, CPAP, restored performance.[15] In another study of college football players, the prevalence of SDB was unexpectedly as high as 14%–34%,[16] compared with the younger general population (in their 30s) at 7.9%–17%.[6–8] These results suggest that SDB is highly prevalent in sports players. In the case of judo players, especially those who belong to heavier weight classes, it is hypothesised that the prevalence of SDB is higher for their age and that SDB may negatively affect their performance by impairment of vigilance and judgement. We hypothesise that CPAP treatment could improve the performances of such players.

To address these hypotheses, we investigated the percentage of judo players with SDB and the potential reduction in their performance in heavy-class judo, then assessed the effect of CPAP treatment.

METHODS

Subjects

Nineteen male judo players from a university student team with body weight ≥100 kg or body mass index (BMI) ≥30 kg/m^2, who gave informed consent, were enrolled and investigated.

Measurements

All participants underwent home-based overnight type 3 sleep monitoring using a Smart Watch PMP-300E (Philips Respironics GK, Eindhoven, The Netherlands), an official tool used for the screening and diagnosis of sleep apnoea in Japan.[17] The device has seven channels that sense airflow, air pressure (noises), percutaneous arterial oxygen saturation (SpO_2), pulse, body movement, respiratory effort and body position. Sleep was defined as the period of patterned body movement that the Smart Watch detected between the time of going to bed and of waking up. A sleep specialist (RS) attended to the participants and evaluated the data on respiratory events and adherence obtained from CPAP as in ordinary outpatients of the clinic.

Data on airflow, air pressure and SpO_2 were used to determine respiratory disturbance index (RDI), snoring index (SI) and the nadir SpO_2 level, respectively. A reduction of airflow by 50% or more for at least 10 s and noises of 8–160 Hz were counted as a snoring event. The numbers of these events per one 'sleep' hour are represented as RDI and SI, respectively. SDB was defined as RDI ≥5. Data were analysed by well-trained sleep technicians, under the supervision of sleep specialists (RS, TaT). The device employed is well established and RDI values derived identified individuals with SDB,[17] as well as showed a good correlation with apnoea-hypopnoea index (AHI) from ordinary polysomnographic data.[18] The Epworth Sleepiness Scale (ESS), which consists of eight questions, was conducted to evaluate EDS.[19] To assess health-related quality of life (HR-QOL), the MOS 8-Item Short-Form Health Survey (SF-8) questionnaire was conducted before and after CPAP treatment, and its physical component summary (PCS) and mental component summary (MCS) were compared between the two conditions.[20]

Participants with SDB and/or those with noticeable sleep apnoea-related symptoms were invited to the second part of the study, in which they saw sleep specialists (RS, TaT) for a diagnosis and underwent CPAP, using a DreamStar Auto (Sefam Healthc'Air, Nancy, France) for at least 1 month. After 3–6 weeks, their conditions were assessed, using the type 3 sleep monitor, as well as ESS and SF-8. CPAP prescription was made by a sleep specialist (SR), who took both the data in the present study and sleep-related symptoms and other clinical information into consideration. In some participants, despite their overall RDI being lower than 5, they were witnessed to have severe sleep-related symptoms, such as heavy snoring, disrupted breathing, EDS, morning headache and polyuria, together with hypertension,[21] or high RDI values linked to certain sleeping positions.

To assess judo performance, those who received CPAP answered six questions regarding the consequences of their treatment: 'Did you have better sleep?' 'Do you feel less fatigued?' 'Was excessive daytime sleepiness improved?' 'Has your performance improved during practice?' 'Did you concentrate more in practice or tournaments?' 'Did you achieve better results in competition?' These were marked on a Likert-type questionnaire as either 'improved greatly', 'improved', 'no change' or 'became worse'. Both 'improved greatly' and 'improved' were regarded as improvement due to CPAP.

Our policy for epidemiological study includes the collection of data, and feedback of data and clinical suggestions to the participants. Therefore, the participants of the present study were involved in the data collection, as well as in the clinical follow-up (RS).

Statistical analysis

All data are presented as median (minimum value – maximum values). Differences between those who underwent CPAP and those who did not were compared and analysed using the Mann-Whitney test (table 1), while the values before and after CPAP were compared and analysed using the Wilcoxon matched signed-rank test (table 2). Pre-CPAP and post-CPAP RDI values were found to follow a normal distribution as indicated by the Kolmogorov-Smirnov test; thus, paired t-tests were employed. Statistical significance was assessed at $p \leq 0.05$. Statistical analyses were conducted using PRISM V.3.02 (GraphPad Software, San Diego, USA).

RESULTS

Nineteen heavyweight-class college judo players aged 21 (19–33) with BMI of 33.9 kg/m^2 (23.3–43.7) were enrolled (table 1). Table 1 also displays sleep-associated data. The participants slept for 340 min (180–570) per day, their ESS score was 12 (4–20), and 12 participants (63%) reported EDS (ESS ≥11). The RDI level was 6.6 (0.6–16.6) and 12 participants (63%) suffered from SDB (RDI ≥5). Their SI was 14.9 (0.9–567) (table 1). Table 1 compares those who underwent CPAP and those who did not, but suffered from SDB (RDI ≥5). There was no difference in age, body attributes, sleep duration, ESS score, RDI values or SI between the two groups.

Seven players underwent CPAP. Although CPAP adherence was rather poor and these participants underwent CPAP for slightly less than 3 hours per night on average (table 2), treatment significantly improved both ESS scores (p=0.04) and RDI (p=0.02), as well as SI (p=0.02). There was no difference in PCS and MCS (as per the SF-8 questionnaire) before and after CPAP treatment.

There was a significant correlation between nadir SpO_2 and RDI (R^2=0.48, p=0.02; figure 1).

Of the seven participants on CPAP, five (72%) experienced better sleep as well as an improvement in fatigue, six (83%) experienced an improvement in daytime sleepiness, and all reported increased performance and concentration in both practice and matches. Two players further claimed that CPAP resulted in better scores in championship.

Table 1 Characteristics of participants

	Total		CPAP(+)		Non-CPAP		P value
n	19		7		7		
Age	21	(19–33)	21	(20–22)	21	(19–33)	1
Height (cm)	178	(179–189)	178	(172–180)	178	(172–185)	0.14
Weight (kg)	125	(73–140)	100	(73–125)	118	(100–140)	0.10
BMI (kg/m^2)	33.9	(23.3–43.7)	31.9	(24.1–39.0)	35.1	(33.8–43.7)	0.95
Sleep-related characteristics							
Sleep duration (min)	340	(180–570)	360	(240–540)	330	(180–570)	0.80
ESS	12	(4–20)	11	(7–16)	13	(4–20)	0.31
ESS ≥11	12		5		5		
RDI (/hour)	6.6	(0.2–16.6)	7.6	(0.2–13.4)	6.6	(5.3–16.6)	0.75
RDI							
<5	6		2		0		
5 to <10	10		3		6		
≥10	3		2		1		
Nadir SpO_2	90.5	(82–95)	89	(83–95)	89	(82–92)	0.62
Snoring index (/hour)	14.9	(0.9–567)	18	(0.9–567)	15.9	(4.5–413.7)	1.0

BMI, body mass index; CPAP, continuous positive airway pressure; ESS, Epworth Sleepiness Scale; RDI, respiratory disturbance index; SpO_2, percutaneous arterial oxygen saturation.

DISCUSSION

SDB is highly prevalent in judo players

Our study is the first to suggest the possibility that SDB is highly prevalent among heavy-class judo players. The percentage of judo players with SDB was 63% and seemed greater than the prevalence in college students in their early 20s, and in young men in their 30s in the general population whose RDI and/or AHI was 5 or greater, 31.7%[17] and 7.9%–17.0%,[6–8] respectively. However, OSA might be more prevalent based on the recent population-based HypnoLaus study, which showed a prevalence of 83.8% in individuals aged 35–60 years; it has been suggested that the prevalence of OSA varies depending on its definition,[22] indicating that those individuals most in need of therapeutic intervention should be identified.

Table 2 Effect of CPAP treatment on SDB parameters (n=7)

	Pre-CPAP		Post-CPAP		P value
Compliance (min)	(–)		178	(74)	
ESS score	11	(7–12)	7	(5–13)	0.04*
11≤ESS, n	5		1		
RDI	7.6	(0.2–6.9)	1.3	(0.3–6.9)	0.02**
5≤RDI, n	5		1		
Snoring index	17.7	(56.7)	0.6	(0.1–11.5)	0.02
SF-8					
PCS	49.2	(42.4–57.9)	50.5	(45.6–55.2)	0.69
MCS	48.8	(38.2–56.4)	51.2	(40.3–55.4)	0.69

Data were presented as median (minimum values – maximum values). *P<0.05, compared with pre-CPAP data.
Defined as the number of respiratory events per 1 hour (events/hour), as in snoring index (events/hour).
**Kolmogorov-Smirnov test indicated that both RDI levels of pre-CPAP and those of post-CPAP showed normal distributions, and thus the data of paired t-test were shown.
CPAP, continuous positive airway pressure; ESS, Epworth Sleepiness Scale; MCS, mental component summary; PCS, physical component summary; RDI, respiratory disturbance index; SDB, sleep disordered breathing.

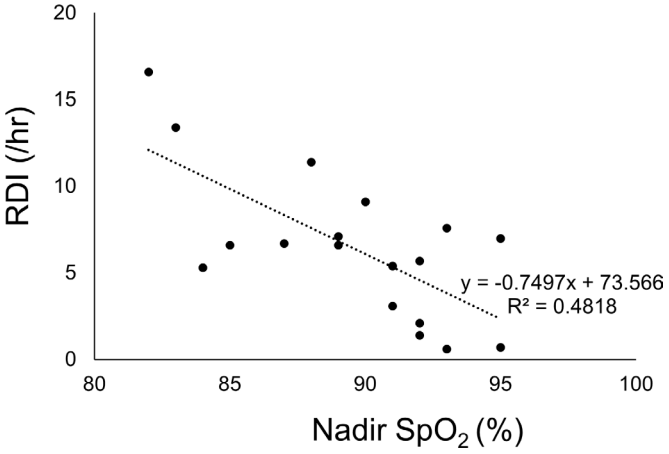

Figure 1 RDI was associated with nadir SpO_2 level (R^2=0.48). RDI, respiratory disturbance index; SpO_2, percutaneous arterial oxygen saturation.

In our study, we employed RDI based on airflow data to assess SDB, rather than ordinary AHI values obtained from standard overnight polysomnography (PSG). The type 3 sleep monitor used in this study is a portable tool more suited to our epidemiological studies than in-lab overnight PSG and is well established.[17] RDI levels given by type 3 devices are still representative of AHI levels,[23] while the RDI values obtained from the device and AHI from ordinary PSG were associated.[18] In addition, our study showed that RDI values were substantially associated with nadir SpO_2 levels (R^2=0.48; figure 1).

A previously published study demonstrated that both circadian rhythm and sleep length affected judo performance, despite the involved short fight time of 5–20 min.[24] This is an indication that judo performance depends on vigilance, which is associated with sleep quality and quantity.

In our study, SDB and EDS and judo performance were shown to be restored by CPAP treatment. The latter suggests that SDB can reduce judo performance. On the other hand, SDB did not significantly alter HR-QOL. This could be because the scores of participants with SDB were within the standard ranges (around 50), which might not be subject to further improvement. Alternatively, the HR-QOL in chronic SDB may not be detectable, such as in the case of underperceived sleepiness in patients with chronic untreated OSA, which Chin *et al*[25] described as the response shift.

CPAP has a therapeutic effect on SDB-related cognitive functions, including vigilance and EDS,[9] depression,[10] anxiety[10] and attention,[11] all of which can influence judo performance. In this study, CPAP improved EDS, suggesting that CPAP was therapeutically effective at least on EDS. Although the CPAP treatment might not be maximised, CPAP may potentiate to give favourable effect on other cognitive functions, which are associated with judo performance.

These results imply that the majority of heavy-class judo players suffer from SDB leading to a reduction in their judo performance and that this can be restored by CPAP treatment. This also postulated that these heavy-class judo players appeared to be physically fit, but showed similar conditions as of obese individuals who are more likely to develop OSA.

Performance and SDB-dependent vigilance in judo players

Previous studies have shown that SDB was associated with worsening psychomotor vigilance in community residents[26] and commercial drivers.[3 4] These results, as well as ours, suggest that reduced vigilance in judo players with SDB leads to reduced judo performance.

Limitations

The results of our study are subject to some limitations. First, we used a homogenous and rather small sample by relying on 19 male Japanese judo players from one university team. In addition, the study design was based on preliminary limited observations. The present study certainly failed to show that heavy-class judo players are more likely to suffer from SDB than those judo players with BMI within the normal range, or than those who were obese but non-judo players. However, in a recently published study employing the same facilities for RDI, 31.7% of male college students, with ages ranging from 21 to 24 years, suffered from SDB (RDI ≥5/hour).[17] Thus, the percentage of SDB appeared to be higher compared with the general young population reported in previous studies,[6–8 17] and therefore being a heavyweight-class judo player is one of the potential risks for SDB, and subsequent health and cognitive dysfunction, in need of behavioural and clinical intervention. Second, the questionnaire employed in the present study was highly subjective and failed to make direct and objective assessments of vigilance and judo performance. Unlike in an individual sport like golf,[15] conditions affecting both competing judo players will influence the result of their match, which makes objective evaluations of judo performances more complicated. Thus, only subjective evaluation was available in this study. However, the therapeutic effect of CPAP on SDB-related cognitive functions was already established,[9–11] which potentially enabled CPAP to improve judo performance in SDB-affected players in the present study. A future objective assessment of vigilance and judo performance, if any, will be able to describe more accurate results. Studies with longer term observations of performance results, such as awards at higher levels of judo (*Dan*), championship records, and frequency of injury and accidents, will also more accurately capture the effect of SDB and treatment results. Third, CPAP treatment for 4 hours or longer has been shown to result in remarkable therapeutic effects on OSA.[13] In contrast, some participants of our study population used CPAP for less than 4 hours, partly due to the short-term design of the study. This suggested that their adherence to CPAP was poor, and the full effect of CPAP on judo performance could not be described, although ESS and performance were still improved. Similar results have been reported in a previous study which showed that even patients with poorer CPAP adherence experienced improvements in ESS scores.[27] Finally, the poor adherence as well as the absence of CPAP-naïve participants in our study might fail to show the full and persuasive impact of CPAP on ESS and judo performance. A longer term study on a population incorporating CPAP-naïve individuals will yield conclusive data, by maximising the therapeutic effect of CPAP. Furthermore, a longer term follow-up study might also be able to investigate the impact of CPAP on future cardiovascular diseases.

Despite these limitations, the present study has yielded missing relevant information. While young sports players may often look fresh and healthy in the media, they might silently suffer from SDB, leading to poorer performance. Our results should alert clinicians and sports trainers to the possible presence of SDB in young sports players and encourage them to consider diagnostic and therapeutic

approaches. This will also enable sports players to attain higher performance.

CONCLUSIONS

The percentage of judo players with SDB may be similar to or even greater than in the general population. As long as the treatment of SDB yields a beneficial effect, SDB screening in judo players is recommended regardless of its prevalence.

In conclusion, sports players such as judo competitors may suffer from SDB, for which an appropriate treatment is recommended to attain better performance.

Contributors All the authors were involved in the conception and design of the work, and in the acquisition, analysis and interpretation of data. They were also involved in the drafting and revising the work for important intellectual content and gave final approval of the revised version. There is no one else who fulfils these criteria for authorship.

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