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To cite this article: Wiwik Budiawan *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1098** 012025

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Bibliometric Analysis of Thermal Comfort and Sleep Quality Research Trends in Indonesia

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Abstract. Using a bibliometric analysis of the publication output associated with research on thermal comfort and sleep quality in Indonesia during the ten-year period 2012–2022, the purpose of this study was to describe current trends and future research areas. The database Scopus was queried for information covering the years 2012 to 2022. We analyzed selected documents containing "thermal comfort," "Indonesia," and "sleep quality" as part of the title, abstract, or key words and reported the following parameters: publication output trends, cooccurrence, author institution, author key words, and index key words. We utilized Visualization of Similarities (VOS) viewer to analyze the files of a bibliographic database in which five co-occurrences occurred. Air conditioning, ventilation, and the tropics accounted for three main cluster of thermal comfort in Indonesia. Meanwhile, in the sleep quality, the main cluster consisted of human, adult, and major clinical study. This study provides a bibliometric analysis demonstrating that, over the past 26 years, the annual number of publications pertaining to sleep quality in Indonesia has increased at a significantly faster rate than literature on thermal comfort. The latest keywords (trend) of thermal comfort are energy efficiency, temperature effect, and field measurement. In the sleep quality topic, the latest keywords are pandemic, controlled study, and Pittsburgh Sleep Quality Index (PSQI).

1. Introduction

Sleep is primarily a behavior. The identification and classification of sleep was based on changes in posture, continued behavior throughout sleep, and an enhanced arousal threshold [1]. A third of the day is devoted to sleep [2], which is an essential daily activity for maintaining good health [3]. A quality night's sleep allows the body to recuperate and prepares them for the day ahead. Sleep is necessary for relieving physical and psychological exhaustion [4], enhancing work performance, and preserving wellness at both school and work [5]. During a typical sleep time, a person has four to six sleep cycles [6]. A newborn requires 12–18 hours of sleep. Between the ages of 5 and 10, children have a 10-hour sleep demand. As teenagers need around 8 and 9 hours while adults need around 7 and 8 hours, the

demand lowers further [7]. Quantity and quality of sleep are distinct concepts. Sleep quantity is defined by how long a person sleeps each night, whereas sleep quality is influenced by how thoroughly a person sleeps. Taking the effort to analyze your sleep quantity will allow you to quickly determine whether or not you are sleeping enough each night. As a general rule, high sleep quality is identified by the following properties: rapid onset of sleep, fewer awakenings, sleep duration commensurate with age recommendations [4], rapid re-entry into sleep, and morning clarity. Alternately, Rehman (2021) concluded that a number of factors could be leading to poor sleep quality [8].

Some research suggests that getting too little sleep can be harmful to your health, and that getting too much sleep might be just as harmful [9]. Thirty-five percent of American adults say they get less than seven hours of sleep per night on a regular basis [10]. Insomnia (30-48% of adults [11] ; women get a 40% higher mortality rate of insomnia than men [12]); obstructive sleep apnea or OSA (15-30% of males [13] and 10-30% of females [14] suffer OSA; 2-9% of adults in the USA suffer OSA); central sleep apnea or CSA; restless leg syndrome; narcolepsy; teeth grinding; talking in sleep; sleep walking Multiple medical effects, including high blood pressure, right ventricular hypertrophy, arrhythmia, and other irregular cardiac rhythms, as well as ischemic heart disease and cerebrovascular dementia [15], have been linked to sleep apnea [15].

Sleep deprivation, reduced attention and judgment, lower work efficiency, and diminished physical strength all diminish life quality and contribute to serious accidents. Moreover, sleep disruptions affect immunological function, biological defense, and maintenance processes [16]. The people may be ignorant of the loss in job productivity induced by sleepiness, which increases the likelihood of incidents and human mistake [5]. Numerous prior studies on indoor thermal conditions, particularly the microenvironment (such as the sleeping space or bedroom), have shown that maintaining a pleasant temperature is essential for sleep quality [17]–[19]. Seasonal variations in interior temperature may have variable effects on sleep measurements. During the summer, there was a considerable association between the inside and outdoor temperatures, however during the cooler months, the correlation was weaker [20].

Generally, thermal comfort is enhanced by complying to the relevant standard's recommendations. Nevertheless, thermal comfort requirements (ASHRAE 55, ISO 7730) are generally applied to all individuals, irrespective of ethnicity or nationality. In addition, physical elements including bedroom temperature, humidity, sound, light, and wind might be considered sleep quality factors. Physical elements resulting from variations in house design and physiological factors resulting from the living environment may influence the factors that affect sleep quality. For instance, there is a difference in the quantity of items in the room and the thermodynamic efficiency between the room of a person living alone in an apartment and the room of a person living alone in a house, and there may be a little difference in the setting.

In developed countries, comfort temperature studies have been extensive: comfort temperatures in workplaces [21], [22], in dwellings during the summer [23]–[25], and throughout the seasons [26]. In Indonesia, however, sleep thermal comfort research (review and empirical) is still scarce. For the purpose of describing this phenomenon, a bibliometric study was performed to determine the trend of research on thermal comfort as well as sleep quality within Indonesia. The current analysis relied on the Scopus database of scholarly literature (in last 10 years). The purpose of this study was to examine the trend of thermal comfort and sleep quality studies in Indonesia. In addition, opportunities for research topics could also be identified.

2. Method

Bibliometric analysis has been widely used in previous review-based research. However, in the thermal comfort and sleep quality is still limited. In the current study, we conducted Bibliometric Analysis to answer the research question (see Figure 1).

Figure 1. Bibliometric Analysis Steps

In the first step, we stated the purpose and scope of the research. The purpose was to explore the research trend of thermal comfort and sleep quality in Indonesia. Furthermore, two main scopes were approached (keywords and publication time). In the second step, we explored bibliographic data in the Scopus database. Three combinations keywords were applied in bibliographic data search, namely: (1) "thermal comfort" AND "Indonesia"; (2) "sleep quality" AND "Indonesia"; and (3) "thermal comfort" AND "sleep quality" AND "Indonesia." Searching bibliographic data was conducted within article title, abstract, and keywords. Furthermore, the selection of article studies was carried out by examining the publication time on the development of thermal comfort and sleep quality in Indonesia between 2012 and 2022. In the third step, co-occurrence analysis was applied based on keyword(s) from two or more documents. Co-occurrence analysis is intended to analyze the content, patterns and trends (trends) of a collection of documents by measuring the strength of keywords/ terms [27]. Co-occurrence analysis is performed to determine the frequency with which three keyword combinations from a research document simultaneously appear in the article under consideration. In the second step, this keyword combination is determined beforehand. The greater the frequency with which comparable keywords appear in a group of papers, the stronger their association. VOS viewer version 1.6.18 (open-source license, Centre for Science and Technology Studies (CWTS) of Leiden University, Netherlands) was applied in the current step to explore data and visualization of network. Network visualization represent the cluster that produced by VOS viewer. Number of research publication each year was analyzed by Microsoft Excel for Mac version 16.59 (Microsoft 365 Subscription, Microsoft, Redmond-United State).

3. Results and Discussions

The growth of publications on the topic of thermal comfort and sleep quality in Indonesia has increased significantly in 2018-2021. As seen in table 1 and figure 1, the number of publications in 2021 reached 21% (out of 135 publications) on thermal comfort topic and 27% (out of 90 publications) on sleep quality topic. In the thermal comfort topic, the documents type is dominated by conference paper (47.4 %), article (39.3 %), and conference review (5.9 %). Institut Teknologi Bandung (17 documents) was the most published article in thermal comfort topic, followed by Universitas Indonesia (13 documents) and Institut Teknologi Sepuluh Nopember (12 documents). In the sleep quality topic, the documents type is dominated by article (92.2 %), conference paper (5.6 %), and conference review (1.1 %). Universitas Indonesia (46 documents) was the most published article in sleep quality topic, followed by Universitas Airlangga (9 documents) and Universitas Gajah Mada (5 documents).

Table 1. Number and percentage publication by year.

Year	TC (f)	TC (%)	SQ (f)	SQ (%)
2012	3	2	1	1
2013	3	2	0	0
2014	3	2	2	2
2015	10	7	1	1
2016	6	4	2	2
2017	13	10	2	2

2018	27	20	11	12
2019	16	12	21	23
2020	16	12	16	18
2021	28	21	24	27
2022	10	7	10	11
Total	135	100	90	100

Abbreviations: TC (f), frequency of thermal comfort; TC (%), percentage of thermal comfort; SQ (f), frequency of sleep quality; SQ (%), percentage of sleep quality.
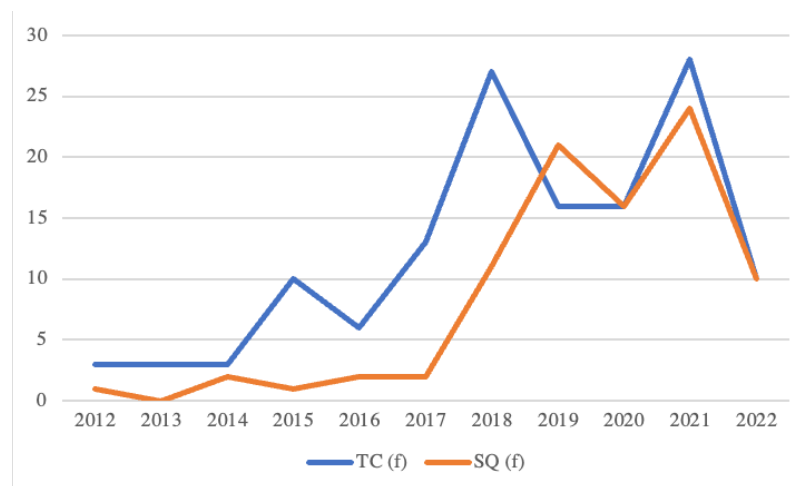

Figure 2. Trend of publication by year.

Abbreviations: TC (f), frequency of thermal comfort; SQ (f), frequency of sleep quality.

Figure 3(a) showed that based on keywords ("thermal comfort" AND "Indonesia"), co-occurrence map of thermal comfort consisted of three clusters. Cluster 1 with red color consisted of 16 keywords: air conditioning, air temperature, atmospheric temperature, buildings, comfort temperatures, buildings, comfort temperatures, cooling, hot-humid climate, indoor air temperature, indoor thermal environment, Jakarta, microclimate, office buildings, PMV, surveys, temperature effect, and thermal environment. Cluster 2 with green color consisted of 11 keywords: architectural design, energy conservation, energy efficiency, energy utilization, heating, houses, housing, residential building, sustainable development, tropical climates, and tropics. Cluster 3 with blue color consisted of 7 keywords: air, air quality, computational fluid dynamics, field measurement, natural ventilation, thermal condition, and ventilation. Figure 3(b) showed that based on keywords ("sleep quality" AND "Indonesia"), co-occurrence map of sleep quality consisted of four clusters. Cluster 1 with red color consisted of 19 keywords: adult, aged, complication, depression, disease severity, educational status, fatigue, health status, insomnia, middle aged, pain, priority journal, psychology, quality of life, sleep, sleep disorder, sleep wake disorders, survey and questionnaire, and young adult. Cluster 2 with green color consisted of 18 keywords: age, article, body mass, child, clinical article, cross-sectional study, female, human, human experiment, hypertension, male, obesity, observational study, physical activity, questionnaire, sleep time, smoking, and stress. Cluster 3 with blue color consisted of 13 keywords: adolescent, controlled study, coronavirus disease 2019, demography, major clinical study, mental health, pandemic, Pittsburgh sleep quality index, prevalence, psychometry, risk factor, social media, and social status. Cluster 4 with yellow color consisted of two keywords: anxiety, and sampling.
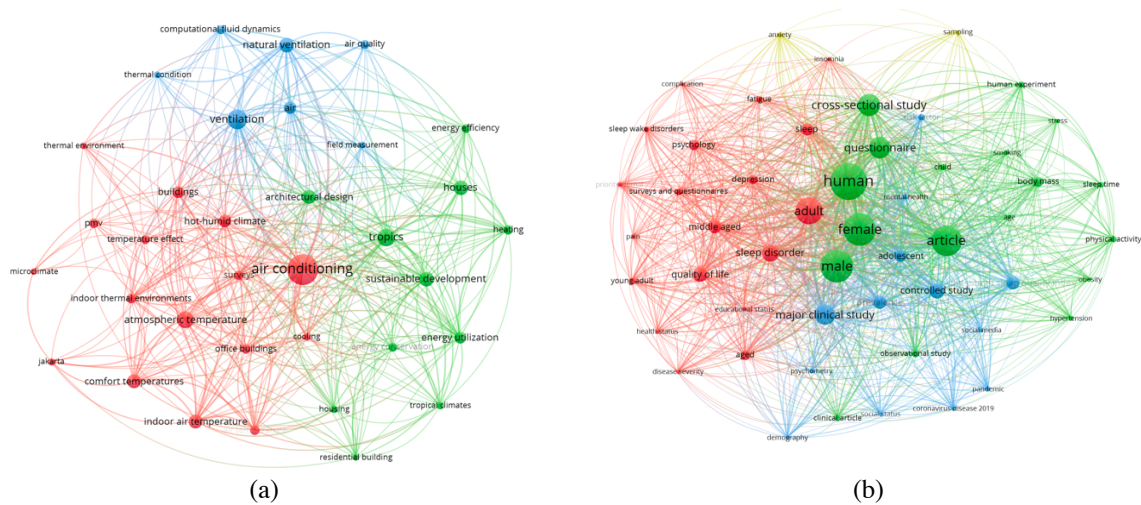
(a)   (b)

Figure 3. Co-Occurrence Map of (a) Thermal Comfort; (b) Sleep Quality

Based on a map of two keywords combinations (Figure 3: "thermal comfort" AND "Indonesia", and "sleep quality" AND "Indonesia"), thermal comfort and sleep quality were not related to each other. Furthermore, by combining the two combinations of keywords ("thermal comfort" AND "sleep quality" AND "Indonesia"), the data search results were also nil. Even though previous research has stated that thermal comfort is essential to maintaining and improving sleep quality [17]–[19]. Indonesia, which is located on the equator line, has a tropical climate and with a dry and rainy season. Indonesia receives roughly 12 hours of sunlight per day with the average temperature same throughout year (21.4 - 28.7 °C) [28]. This may indicate that thermal comfort has not been sufficiently considered in relation to sleep quality. In the future, however, with the emergence of the phenomenon of global warming, the study of thermal comfort and sleep quality will be crucial.

4. Conclusion

The highest frequency publication between 2012 and 2022 was 28 (21%) publications for thermal comfort and 24 (27%) publications for sleep quality. The document type dominated by conference article for thermal comfort and article for sleep quality. Furthermore, analysis found the latest keywords (year: 2022) of thermal comfort and sleep quality topic. The latest keywords (trend) of thermal comfort are energy efficiency, temperature effect, and field measurement. In the sleep quality topic, the latest keywords are pandemic, controlled study, and Pittsburgh Sleep Quality Index (PSQI). In sleep quality studies, thermal comfort has not been accounted for. With the emergence of the phenomenon of global warming, it will be fascinating to further investigate the relationship between thermal comfort and sleep quality.

Acknowledgement

References
[1]   R. D. Ogilvie, "The process of falling asleep," *Sleep Med. Rev.*, vol. 5, no. 3, pp. 247–270, 2001, doi: 10.1053/smrv.2001.0145.
[2]   M. Fabbri, L. Tonetti, M. Martoni, and V. Natale, "Sleep and prospective memory," *Biol. Rhythm Res.*, vol. 45, no. 1, pp. 115–120, Jan. 2014, doi: 10.1080/09291016.2013.830510.
[3]   K. A. Lee, "An overview of sleep and common sleep problems.," *ANNA J.*, vol. 24, no. 6, p. 86716, 1997.
[4]   M. Hirshkowitz *et al.*, "National sleep foundation's sleep time duration recommendations: Methodology and results summary," *Sleep Heal.*, vol. 1, no. 1, pp. 40–43, 2015, doi:

INCRID 2022

IOP Conf. Series: Earth and Environmental Science   1098 (2022) 012025

IOP Publishing

doi:10.1088/1755-1315/1098/1/012025

10.1016/j.sleh.2014.12.010.

[5]   Japan Ministry of Health Labour and Welfare, "Sleep guidelines for health promotion (in Japanese)," 2014, [Online]. Available: https://www.mhlw.go.jp/file/06-Seisakujouhou-10900000-Kenkoukyoku/0000047221.pdf

[6]   A. K. Patel, V. Reddy, and J. F. Araujo, "Physiology, Sleep Stages.," Treasure Island (FL), 2021.

[7]   K. Truong, "Sleep Statistics," *Sleep Foundaition*, 2021. https://www.sleepfoundation.org/how-sleep-works/sleep-facts-statistics (accessed Oct. 05, 2021).

[8]   A. Rehman, "How To Determine Poor Sleep Quality," *Sleep Foundaition*, 2021. https://www.sleepfoundation.org/sleep-hygiene/how-to-determine-poor-quality-sleep (accessed Oct. 05, 2021).

[9]   D. F. Kripke, L. Garfinkel, and D. L. Wingard, "Mortality Associated With Sleep Duration and Insomnia," vol. 59, 2002.

[10]   CDC, "Short Sleep Duration Among US Adults," 2017. https://www.cdc.gov/sleep/data_statistics.html (accessed Oct. 05, 2021).

[11]   D. Patel, J. Steinberg, and P. Patel, "Insomnia in the elderly: A review," *J. Clin. Sleep Med.*, vol. 14, no. 6, pp. 1017–1024, 2018, doi: 10.5664/jcsm.7172.

[12]   J. A. Mong and D. M. Cusmano, "Sex differences in sleep: Impact of biological sex and sex steroids," *Philos. Trans. R. Soc. B Biol. Sci.*, vol. 371, no. 1688, 2016, doi: 10.1098/rstb.2015.0110.

[13]   T. Young, M. Palta, J. Dempsey, P. E. Peppard, F. J. Nieto, and K. M. Hla, "Burden of sleep apnea: Rationale, design, and major findings of the Wisconsin sleep cohort study," *Wis. Med. J.*, vol. 108, no. 5, pp. 246–249, 2009.

[14]   P. E. Peppard, T. Young, J. H. Barnet, M. Palta, E. W. Hagen, and K. M. Hla, "Increased prevalence of sleep-disordered breathing in adults," *Am. J. Epidemiol.*, vol. 177, no. 9, pp. 1006–1014, 2013, doi: 10.1093/aje/kws342.

[15]   J. P. Kiley, N. Edelman, and S. Derderian, "Cardiopulmonary disorders of sleep," in *Wake Up America: A National Sleep Alert*, Vol.2 (Rep., U.S. Department Health and Human service, Ed. U.S. Department Health and Human service, 1994, pp. 10–75.

[16]   D. F. Dinges, S. D. Douglas, S. Hamarman, L. Zaugg, and S. Kapoor, "Sleep deprivation and human immune function," *Adv. Neuroimmunol.*, vol. 5, pp. 97–110, 1995, doi: 10.1016/0960-5428(95)00002-j.

[17]   G. Zheng, K. Li, and Y. Wang, "The effects of high-temperature weather on human sleep quality and appetite," *Int. J. Environ. Res. Public Health*, vol. 16, no. 2, pp. 1–13, 2019, doi: 10.3390/ijerph16020270.

[18]   J. A. F. van Loenhout *et al.*, "The effect of high indoor temperatures on self-perceived health of elderly persons," *Environ. Res.*, vol. 146, pp. 27–34, 2016, doi: 10.1016/j.envres.2015.12.012.

[19]   W. Budiawan and K. Tsuzuki, "Thermal Comfort and Sleep Quality of Indonesian Students Living in Japan during Summer and Winter," *Buildings*, vol. 11, no. 8, p. 326, Jul. 2021, doi: 10.3390/buildings11080326.

[20]   J. L. Nguyen, J. Schwartz, and D. W. Dockery, "The relationship between indoor and outdoor temperature, apparent temperature, relative humidity, and absolute humidity," *Indoor Air*, vol. 24, no. 1, pp. 1–19, 2014, doi: 10.1111/ina.12052.The.

[21]   S. A. Damiati, S. A. Zaki, H. B. Rijal, and S. Wonorahardjo, "Field study on adaptive thermal comfort in office buildings in Malaysia, Indonesia, Singapore, and Japan during hot and humid season," *Build. Environ.*, vol. 109, pp. 208–223, 2016, doi: 10.1016/j.buildenv.2016.09.024.

[22]   M. S. Mustapa, S. A. Zaki, H. B. Rijal, A. Hagishima, and M. S. M. Ali, "Thermal comfort and occupant adaptive behaviour in Japanese university buildings with free running and cooling mode offices during summer," *Build. Environ.*, vol. 105, pp. 332–342, 2016, doi: 10.1016/j.buildenv.2016.06.014.

[23]   H. B. Rijal, M. A. Humphreys, and J. F. Nicol, "Adaptive model and the adaptive mechanisms

for thermal comfort in Japanese dwellings," *Energy Build.*, vol. 202, no. August, p. 109371, 2019, doi: 10.1016/j.enbuild.2019.109371.

[24]　H. B. Rijal, M. Honjo, R. Kobayashi, and T. Nakaya, "Investigation of comfort temperature, adaptive model and the window-opening behaviour in Japanese houses," *Archit. Sci. Rev.*, vol. 56, no. 1, pp. 54–69, 2013, doi: 10.1080/00038628.2012.744295.

[25]　H. B. Rijal, M. A. Humphreys, and F. Nicol, "Study on adaptive model. Part 3. Development of the adaptive model for thermal comfort in Japanese houses," *Anu. Meet. Archit. Inst. Japan*, pp. 403–406, 2014.

[26]　H. B. Rijal, M. A. Humphreys, and J. F. Nicol, "Towards an adaptive model for thermal comfort in Japanese offices," *Build. Res. Inf.*, vol. 45, no. 7, pp. 717–729, 2017, doi: 10.1080/09613218.2017.1288450.

[27]　M. A. De Looze and J. Lemarié, "Corpus relevance through co-word analysis: An application to plant proteins," *Scientometrics*, vol. 39, no. 3, pp. 267–280, 1997, doi: 10.1007/BF02458530.

[28]　BMKG, "Climate change extreem in Indonesia," *Meteorological, Climatological, and Geophysical Agency*, 2021. https://www.bmkg.go.id/iklim/?p=ekstrem-perubahan-iklim&lang=ID (accessed Jan. 20, 2021).