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Retraction

Retracted: Bias and Motivation of Energy Monitoring during Exercise under Scientometric Perspective

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] G. Chen, Y. Su, and M. Asif Shah, "Bias and Motivation of Energy Monitoring during Exercise under Scientometric Perspective," *Security and Communication Networks*, vol. 2022, Article ID 9704890, 10 pages, 2022.

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Research Article

Bias and Motivation of Energy Monitoring during Exercise under Scientometric Perspective

Gang Chen,[1] **Yuqing Su**,[2] **and Mohd Asif Shah**[3]

[1]*School of Physical Education, Nanjing Xiaozhuang University, Nanjing, China*
[2]*Department of Tourism and Nutrition, Nanjing Jinling Technical Vocational College, Nanjing, China*
[3]*Bakhtar University, Kabul, Afghanistan*

Correspondence should be addressed to Yuqing Su; suyuqingnanjing@gmail.com and Mohd Asif Shah; ohaasif@bakhtar.edu.af

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The thermodynamics is of great value for better practical applications of Internet of Things (IoT). With the development of IoT, Wearable Energy Harvester can provide more abundant measurement methods for human engineering and human heat. However, how close the relationship is between traditional individual thermal measurement and emerging technologies remains a topic that has not been paid attention to. Therefore, this paper first sorts and summarizes the literature of human calorimetry and then shows the cross field of Wearable Energy Harvester and traditional research using graph theory. Specifically, this paper presents the evolution of the research field in the form of dual-map overlays by characterizing the network structure and measuring the structural transformation of the knowledge network. With Web of Science as the data source and CiteSpace 5.0 software as the tool to make a knowledge graph for quantitative statistics, it is found that the research hotspot of individual energy expenditure is in the physiological field. The starting point of individual thermal energy monitoring technology represented by Wearable Energy Harvester is to aid with human health. However, as time progresses, although the development of this field still focuses on the fields of chemical industry and materials, it has gradually become closely related to multiple disciplines such as the monitoring of thermal energy during high-intensity sports training.

1. Introduction

Physical Activity normally refers to the physical activity generated by skeletal muscle contraction and the activity with increased body energy expenditure at the level of Basal Metabolic Rate (BMR). Life activities are accompanied by metabolism, including material metabolism and energy metabolism [1]. Material metabolism is the continuous exchange of substances between the human body and the outside world, including metabolic changes in two different directions: anabolism and catabolism [2]. Anabolism refers to the continuous conversion of nutrients ingested by the human body, including sugar, fat, protein, etc. into the tissue components of the body or renewal of aging tissue components. The continuous storage of energy during anabolism is called assimilation. Catabolism refers to the continuous decomposition of body tissue components [3]. The process of catabolism is accompanied by the release of energy for the human body to carry out various functional activities normally, which is called alienation [4]. Energy metabolism refers to the release, storage, and utilization of energy in metabolism [5, 6]. The development of the human body, the transformation, and repair of tissue components, and the energy required for various life activities are based on the continuous progress of metabolism [7]. In the study of human energy metabolism, it is necessary to clarify not only the daily energy intake from food but also the daily total energy demand and specific energy expenditure [8]. Therefore, the effective monitoring of energy expenditure in the process of exercise is of great significance to achieve the goal of doing sports scientifically. Studies have shown that too little physical activity can affect human health [9, 10]. Therefore, research on human heat and its expenditure has been a hot research field in Internet of Things (IoT). For example, Nuzzo [11], Khobragade et al. [12], and Naser et al. [13] support that thermal energy monitoring system will rapidly form an advanced Internet of Things (IoTs) to guide industry and people's lifestyles and health, especially under the development of renewable technology [14–16].

However, is it a single subject topic or an interdisciplinary topic to achieve a more objective, reliable, convenient, and accurate measurement of energy expenditure in the process of human movement? The answer is unclear, which is the study object of this paper. In the study of human thermodynamics, there is still a lack of relevant literature to clarify the progress of discipline research. From the preliminary observation, the answer to this question is likely to be an interdisciplinary question. In the twenty-first century, to capture human heat, acceleration sensors and other instruments are used to extract and analyze human energy data [17, 18]. So far, commonly used mobile portable devices such as smart bracelets have been able to provide information about the number of steps, exercise distance, duration, energy expenditure, etc. of physical activity [19–21]. The monitoring of body heat from physical activity during exercise provides a reliable auxiliary for public fitness and professional training. However, it is obvious that science and technology for human thermal energy capture need to be based on two disciplines, namely, physiology and engineering technology. Most of the traditional research on energy expenditure focuses on physiological themes. However, in recent years, there has been a gradual rise in research that combines sports heat expenditure with wearable devices. For example, Kaplan [22] used Actigraph 7164 and multiaxis Actical accelerometer to verify a movable metabolic system. Children carried out 9 different activities, including complex whole-body movements while wearing the accelerometer. They found that when the data of all activities were put together, the accelerometer was very effective in distinguishing sedentary behaviour, and the prediction of moderately strenuous activity was relatively reasonable. However, for the high-intensity jumping activities, there was no data on the corresponding accelerometer to predict energy expenditure. There are other similar studies such as Jimmy et al. [23], Crouter et al. [24], and Buchan et al. [25]. Although complex aerobic exercise is included in the calculation of human heat expenditure, due to the complexity and extensiveness of physical activity [26–28], the studies do not provide clear information on the effectiveness of prediction by the accelerometer in high-intensity complex physical activity. Therefore, how to combine traditional physiological research and portable microsystem to predict energy expenditure in high-intensity complex exercise is a core problem to be solved, which obviously needs more in-depth interdisciplinary cooperation. However, at present, we are still unable to identify the obstacles to such interdisciplinary cooperation, what the current research bias is, and how to promote more effective and comprehensive cooperation in the future. These constitute the specific research problems that this paper intends to solve. Therefore, this paper takes the relevant literature of energy expenditure and Wearable Energy Harvest collected in the core collection of Web of Science (WOS) from 2000 to 2020 as the research object, draws the knowledge graph with CiteSpace tool, sorts and summarizes it from the perspective of metrology, and shows its phased research trend and bias at the same time.

2. Methodology

The core collection of the WOS database is used as the source database for retrieval. The way to obtain the literature about energy expenditure is to search the topics including "Human Energy Expenditure," "Exercise Energy Expenditure," and "Body Energy Expenditure" [29]. Timespan = 2000~2020, literature type = (article) or (review), a total of 594 literature titles were retrieved (retrieval date: December 24, 2020). In addition, in the same way, we obtained 1681 pieces of literature information about "Wearable Energy Harvest." The search information was set to "full record including the cited references" and saved in the format of download. tex, using CiteSpace Version 5.0 software to draw the knowledge network graph of the literature. CiteSpace information visualization software is developed by Professor Chen Chaomei of Drexel University based on citation analysis theory to extend the theoretical scope in Java language. It is one of the most characteristic and influential application software programs in visualization analysis of international literature information in recent years. CiteSpace uses computer algorithms and interactive visualizations to free people from some of the time-consuming and laborious burdens, allowing us to focus our efforts on more important and critical analysis problems.

The knowledge network graph can be used as a visual knowledge graph or a serialized knowledge pedigree. This paper divides the literature into two stages: 2000–2010 and 2010–2020, and uses the graphs of the two stages to analyze the hot spots and development trends of the field. However, for the relevant literature of "Wearable Energy Harvest," we have chosen to divide it into 2004–2010 and 2010–2020 because the starting year of the relevant literature is 2004. The overall comparison with energy expenditure can also make it more convenient for us to describe the research progress. At the same time, this paper uses the "JCR journal maps" function in CiteSpace software system to draw the dual-map overlay of the journal, explore the evolution process and development context of the knowledge base of academic journals, and reveal the knowledge diffusion and the law of knowledge dissemination. Then, this paper constructs the network structure transformation model to predict journals that may change the network structure in the field of citation analysis research in the future and look for journals that may cause changes in the network structure in the field of citation analysis research in the future.

3. Results

3.1. Description of the Research Hotspot. Based on the keywords related to energy expenditure, with the keywords of 594 documents published between 2000 and 2020 and the main fields of 304 journals retrieved from the WOS core collection as the source of research fields and hot spot analysis, the data set was divided into two stages of 2000–2010 and 2011–2020 to explore the distribution and evolution of hot spots in different stages, respectively. In the first stage of 2000–2010, the keyword co-occurrence analysis was selected, and the keyword co-occurrence network was obtained. There was a total of $N = 286$ nodes and $E = 725$ connections in the network and the network density was 0.0178. Similarly, to achieve intuitive comparison, this study is to explore the distribution and evolution of hot spots in different stages of "Wearable Energy Harvest" at the same time with the keywords of 1681 documents published between 2004 and 2020 and the main fields of 769 journals retrieved from the WOS core collection as the research fields and hot spot analysis sources. Based on the data from 2004 to 2020, the keyword co-occurrence analysis was selected, and the keyword co-occurrence network was obtained. There was a total of $N = 451$ nodes and $E = 972$ connections in the network, and the network density was 0 0096.

As can be seen from Figure 1(a) and Figure 1(b), the research between 2000 and 2010 mainly focused on (1) weight loss (#0 weight loss), including the keywords physical activity, adipose tissue, indirect calorie calorimetry, etc.; (2) AMPK (Adenosine 5′-monophosphate (AMP) activated protein kinase) research (#1 ampk), that is, AMP-dependent protein kinase, which is a key molecule in the regulation of biological energy metabolism and the core of research on diabetes and other metabolic diseases. The main keywords included are energy expenditure, skeletal muscle, insulin tolerance beta-adrenergic blockade, etc.; (3) bone mineral content research (#2 bone mineral content), including keywords gene expression, brown adipose tissue, cancer cachexia, etc.; (4) mitochondrial function (#3 mitochondrial function), including keywords aerobic exercise, resting metabolic rate, etc.; (5) energy metabolism (#4 energy metabolism), including keywords oxygen consumption, energy metabolism, etc.; (6) blood-brain barrier (#5 blood-brain barrier) including keywords adaptive thermogenesis, insulin sensitivity, etc.; (7) lipid hydroperoxide (#6 lipid hydroperoxide) including keywords food intake, growth hormone, etc.

In the second stage of 2011–2020, the keyword cooccurrence analysis was selected, and the keyword cooccurrence network was obtained. There was a total of $N = 315$ nodes and $E = 632$ connections in the network, and the network density was 0.0128. As can be seen from Figure 2, the research between 2000 and 2010 mainly focused on (1) skeletal muscle (#0 skeletal muscle), including keywords skeletal muscle, insulin resistance, etc.; (2) fat (#1 fat), including keywords energy expenditure, obesity, etc.; (3) body energy expenditure (#2 body energy expenditure), including keywords adipose tissue, insulin sensitivity, etc.; (4) brown adipose tissue (#3 brown adipose tissue) including keywords gene expression, thermogenesis, etc.; (5) aerobic exercise (#4 aerobic exercise) including keywords body composition, food intake, etc.; (6) heart rate (#5 heart rate), including keywords double labeled water, human energy expenditure, etc.; (7) dynamic energy homeostasis (#6 energy homeostasis) including keywords metabolism, calorie restriction, etc.

As can be seen from Figure 3, the research between 2004 and 2020 mainly focused on (1) polyvinylidene fluoride (#0 polyvinylidene fluoride) including keywords mechanical energy, vinylidene fluoride, water wave energy, etc.; (2) electronic skin (#1 electronic skin) including keywords supercapacitor, electronic skin, strain sensor, etc.; (3) energy harvesting (#2 energy harvesting), including keywords triboelectric nanogenerator, energy harvesting and piezoelectric nanogenerator, etc.; (4) electricity (#3 electricity), including keywords wearable electronics, electromagnetic generator, etc.; (5) body heat (#4 body heat) including keywords wearable device, carbon nanotube, etc.; (6) sensitized solar cell (#5 sensitized solar cell) including keywords lithium ion battery, graphene oxide, etc.; (7) flexible electronics (#6 flexible electronics) including keywords energy conversion, energy harvester, etc.; (8) performance (#7 performance) including keywords performance, harvesting biomechanical energy, etc.; (9) field effect transistor (#8 field effect transistor) including keywords electronics, field effect transistor, reduced graphene oxide, etc.; (10) modified gel polymer electrolyte (#9 PVDF-HFP) including keywords electrical conductivity, composite film (composite film), etc.

3.2. The Evolution of Research Frontiers

3.2.1. Energy Expenditure. With the keyword burst terms detection technology (Burst analysis) in CiteSpace software, the keywords in 594 documents in the two phases of 2000–2010 and 2011–2020 were analyzed, respectively, to determine the words or topics that received wide attention by scholars in each period. To understand the development trend of the research frontier, the detected keywords were sorted according to the emergence time and intensity. After sorting and classification, it is found that the main research frontier from 2000 to 2010 mainly focused on brown adipose tissue and gene expression from 2000 to 2002; body mass index, skeletal muscle, and resting metabolic rate from 2003 to 2006; weight loss and energy metabolism from 2007 to 2010; obesity, body fat, coronary heart disease, insulin resistance, etc. from 2011 to 2014 (see Table 1); energy intake, white fat, uncoupling protein 1, adaptive thermogenesis, PGC 1 alpha, glucose homeostasis, glucose uptake, etc. from 2015 to 2017 (see Table 2); adipose tissue, human energy expenditure, indirect calorimetry, PPAR gamma, cold heat generation, etc. from 2018 to 2020 (see Table 2).

3.2.2. Wearable Energy Harvest. With the keyword burst terms detection technology (Burst analysis) in CiteSpace software, the keywords in 1681 documents from 2004 to 2020 were analyzed to determine the words or topics that received wide attention by scholars in each period (see Table 3). To understand the development trend of the research frontier, the detected keywords are sorted according to the emergence time and intensity. After sorting and classification, it is found that the main research frontier mainly focused on power, energy harvesting, nanowires, energy conversion, nanogenerators, etc. from 2007 to 2014, on research about energy source, networks, electrification, etc. from 2015 to 2016, on research about conversion

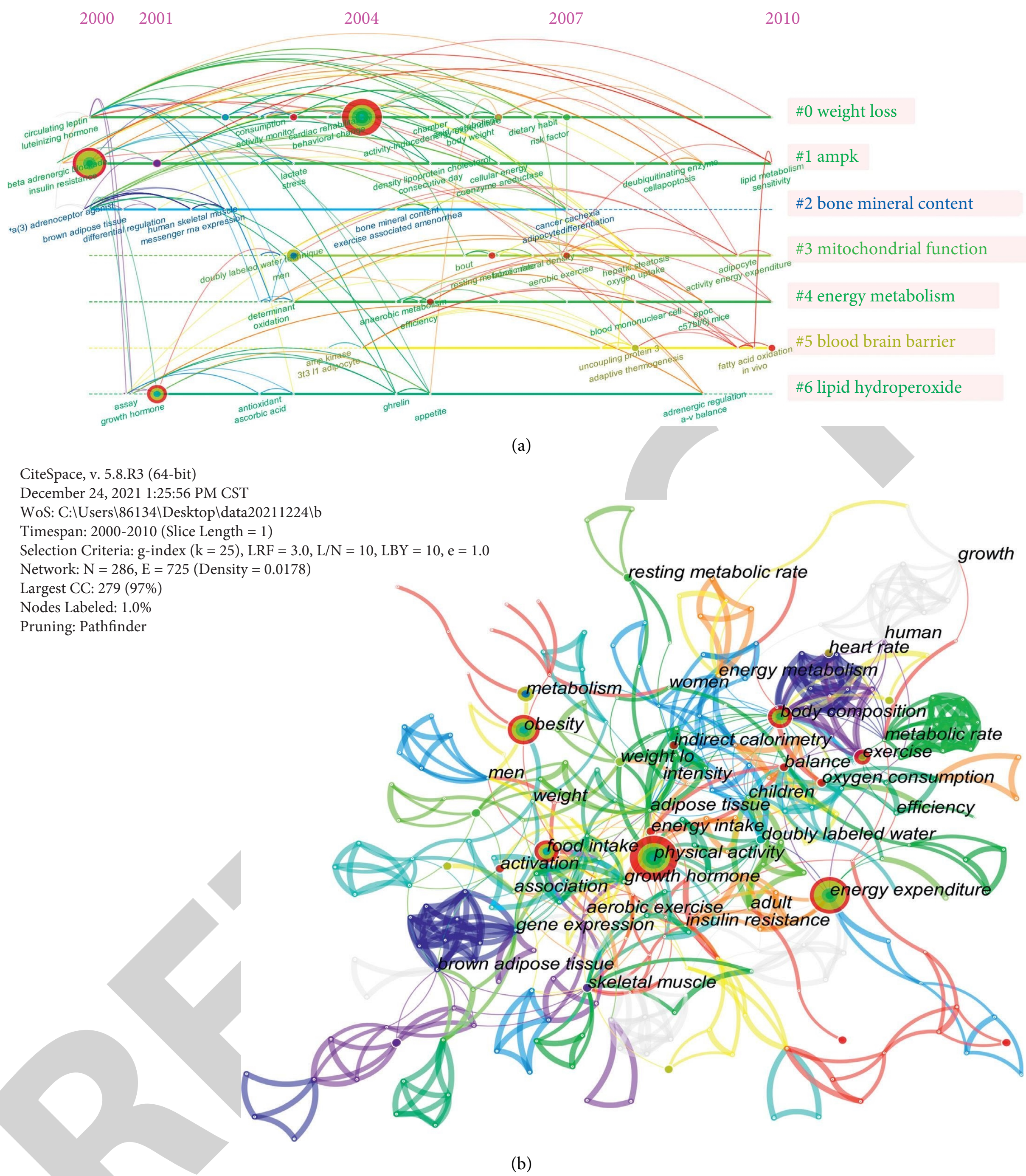


Figure 1: Keywords cooccurrence timeline map from 2000 to 2010.

efficiency, ion batteries, sensitized solar cells, and wearable sensors from 2017 to 2018, and on research about nanoparticles, thermal conductivity, etc. from 2019 to 2020.

4. Dual-Map Overlay

The subject field is usually composed of elements like basic concepts, principles of scientific knowledge, etc. Reasonable and effective use of subject knowledge base can reveal the connection and development law of different knowledge systems within the subject. The knowledge base in different stages is drawn by using the JCR-based classification map in CiteSpace software. It should be noted that the left side of the map represents the subject field of the target literature set data, which is called the existing research field, and the right side represents the subject field of the references of the target data set, which is called the knowledge base field. The changes of a knowledge base can

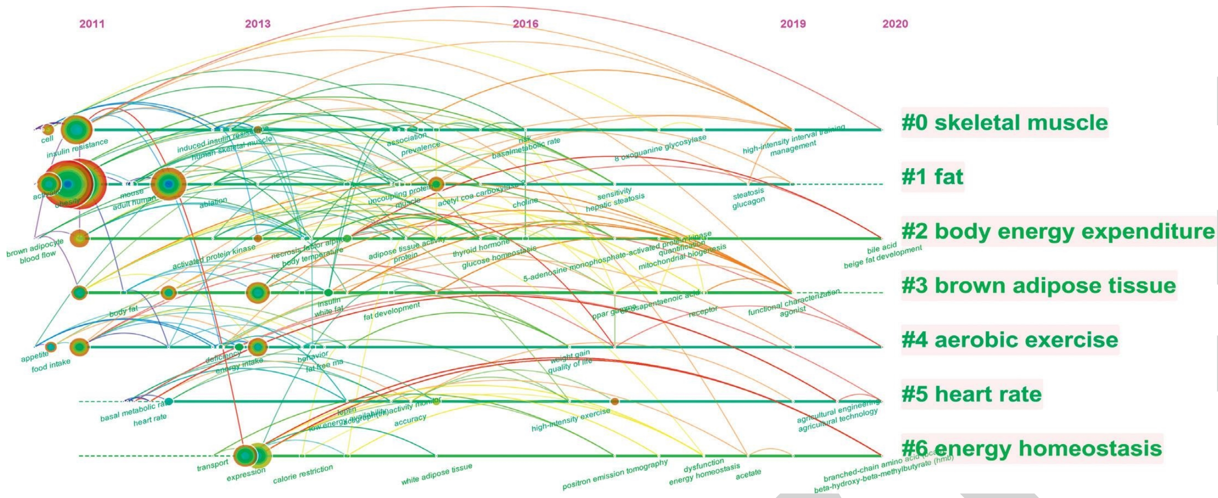


Figure 2: Keywords cooccurrence timeline map from 2011 to 2020.

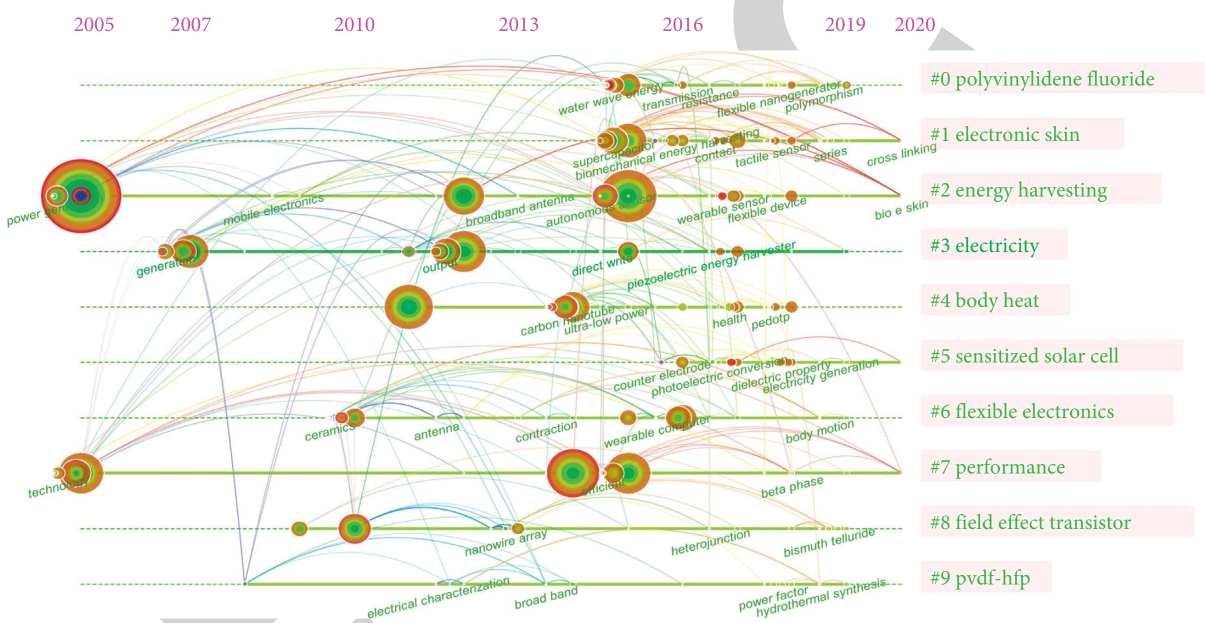


Figure 3: Common map of keyword cooccurrence from 2004 to 2020.

Table 1: Main keywords with the strongest citation bursts from 2000 to 2010.

Keywords	Year	Strength	Begin	End	2000–2010
Brown adipose tissue	2000	1.66	2000	2002	
Gene expression	2000	1.48	2000	2002	
Doubly labeled water	2000	3.17	2002	2005	
Body mass index	2000	1.01	2002	2004	
Skeletal muscle	2000	1.06	2005	2006	
Resting metabolic rate	2000	2.65	2006	2007	
Weight loss	2000	2.31	2006	2010	
Energy metabolism	2000	1.11	2008	2010	

be clearly seen through the analysis of the subject field of the references of the target data set, and the diffusion of knowledge can be clearly seen through the analysis of the subject field of the target data set.

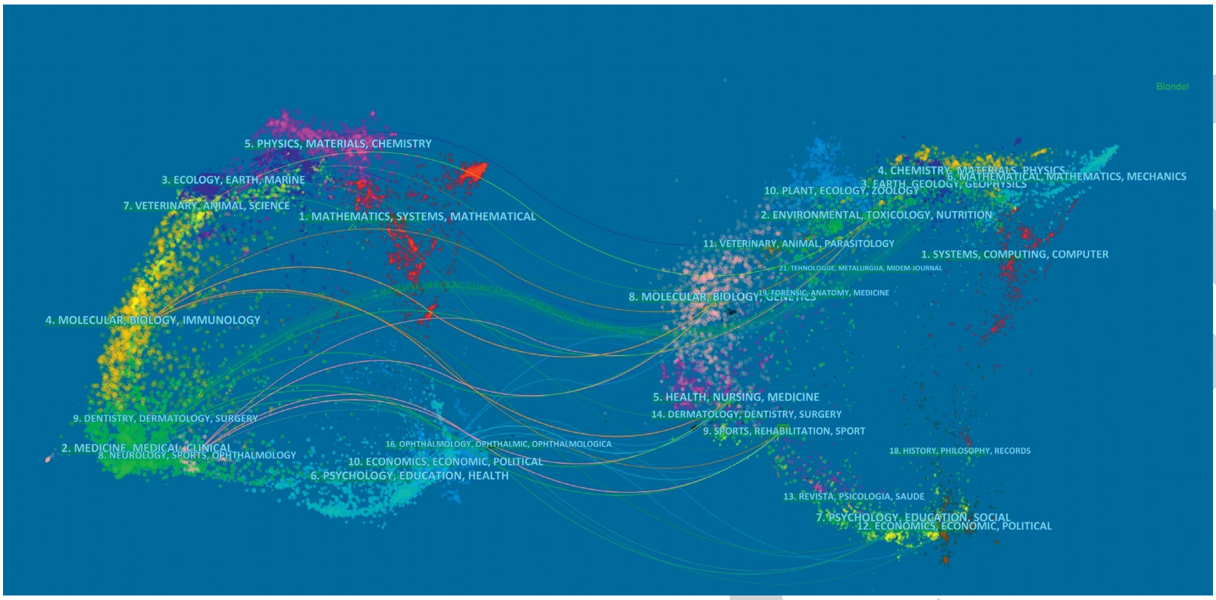
In the field of energy expenditure (see Figures 4(a) and 4(b)), the distribution boundary of related research from 2000 to 2010 is relatively vague, and its core fields are not very prominent. The research is mainly in the fields of

Table 2: Main keywords with the strongest citation bursts from 2011 to 2020.

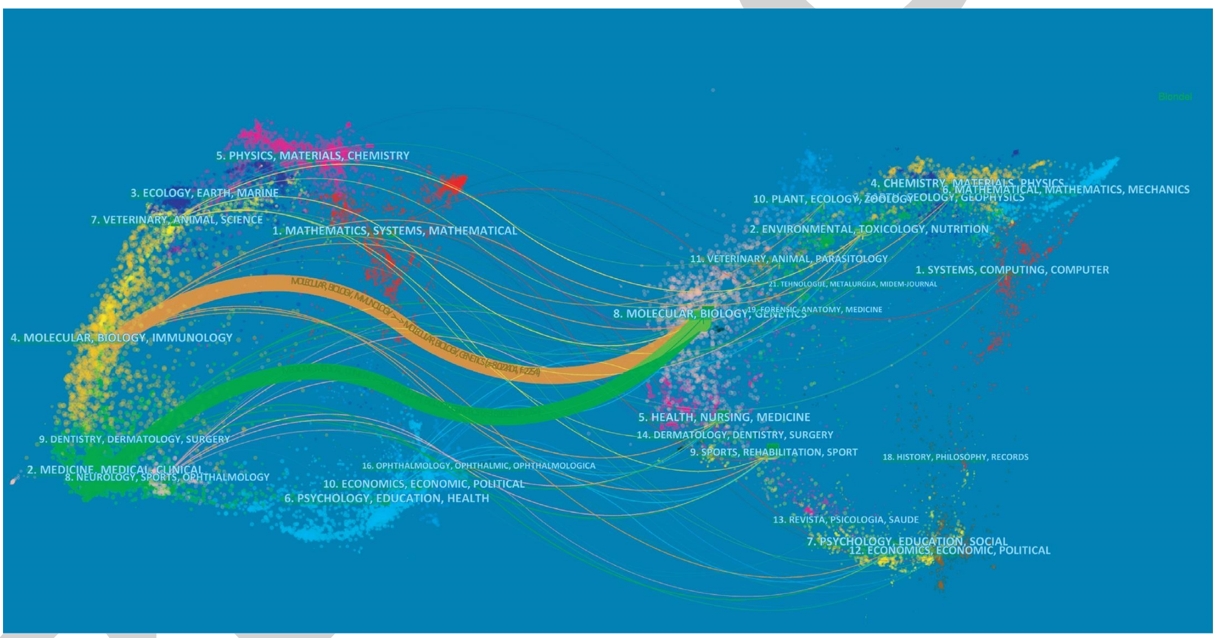
Keywords	Year	Strength	Begin	End	2011–2020
Oxidation	2011	2.01	2011	2014	
Adiposity	2011	1.45	2011	2013	
Body fat	2011	2.31	2012	2014	
Heart rate	2011	1.49	2012	2013	
Coronary heart disease	2011	2.12	2013	2014	
Induced insulin resistance	2011	1.7	2013	2014	
Aerobic exercise	2011	2.22	2014	2017	
Energy intake	2011	2.09	2014	2016	
White fat	2011	1.74	2014	2016	
Uncoupling protein 1	2011	2.64	2015	2016	
Adaptive thermogenesis	2011	1.7	2015	2017	
PGC 1 alpha	2011	2.53	2016	2018	
Glucose homeostasis	2011	1.9	2016	2017	
Glucose uptake	2011	1.5	2016	2018	
Adipose tissue	2011	4.45	2017	2020	
Human energy expenditure	2011	2.5	2017	2018	
Indirect calorimetry	2011	2.06	2017	2020	
PPAR gamma	2011	1.94	2017	2018	
Weight	2011	3.08	2018	2020	
Cold induced thermogenesis	2011	1.75	2018	2020	

Table 3: Main keywords with the strongest citation bursts from 2004 to 2020.

Keywords	Year	Strength	Begin	End	2004–2020
Walking	2004	4.97	2007	2015	
Electricity	2004	3.03	2007	2016	
Generation	2004	1.93	2007	2013	
Circuit	2004	2.8	2008	2016	
Generating electricity	2004	3.84	2009	2015	
Conversion	2004	2.5	2009	2014	
Energy harvesting	2004	5.18	2010	2014	
Ceramics	2004	1.9	2010	2016	
Nanowire	2004	2.72	2011	2015	
Driven	2004	2.48	2012	2014	
Output	2004	1.94	2012	2014	
Array	2004	1.88	2012	2014	
Motion	2004	4.05	2013	2015	
Nanogenerator	2004	3.52	2014	2015	
Contact electrification	2004	2.96	2014	2015	
Battery	2004	2.14	2014	2017	
Graphene	2004	3.51	2015	2016	
Harvesting biomechanical energy	2004	2.67	2015	2016	
Power source	2004	2.25	2015	2016	
Network	2004	2.25	2015	2016	
Electrification	2004	2.2	2015	2016	
Counter electrode	2004	2.09	2016	2017	
Conversion efficiency	2004	2.09	2016	2017	
Ion battery	2004	2.09	2016	2017	
Pressure	2004	1.74	2016	2017	
Sensitized solar cell	2004	2.7	2017	2018	
Wearable sensor	2004	2.16	2017	2018	
Nanoparticle	2004	2.18	2018	2020	
Thermal conductivity	2004	1.92	2018	2020	



(a)



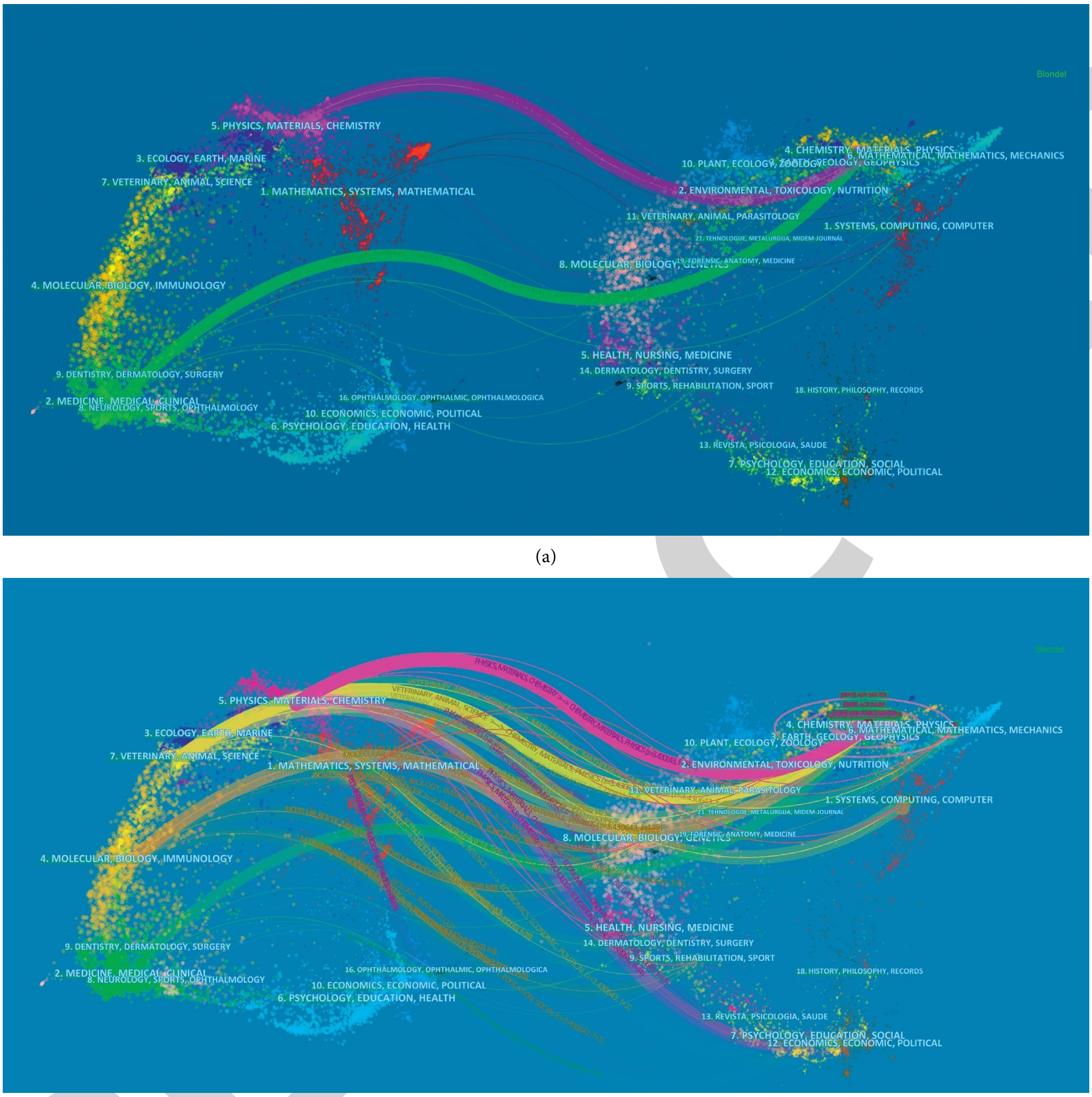
(b)

FIGURE 4: The dual-map overlay in the field of energy expenditure. (a) 2000–2010. (b) 2011–2020.

"MEDICINE, MEDICAL, CLINICAL," and the marginal fields are "NEUROLOGY, SPORTS, OPHTHALMOLOGY," "MOLECULAR, BIOLOGY, IMMUNOLOGY," "VETERINARY, ANIMAL, SCIENCE," "PSYCHOLOGY, EDUCATION, HEALTH," etc. In this period, the knowledge base is "1, 2, 5, 6, 7, 8, 9, 10, 11, 12," of which is the 6th field and the core knowledge base.

Compared with the stage of 2000–2010, the human energy field has a clearer research field in the stage of 2011–2020, forming a core field of "MEDICINE, MEDICAL, CLINICAL" and "MOLECULAR, BIOLOGY, IMMUNOLOGY" and marginal fields of "NEUROLOGY, SPORTS, OPHTHALMOLOGY," "PSYCHOLOGY, EDUCATION, HEALTH," "VETERINARY, ANIMAL, SCIENCE," etc. In this period, the knowledge base is "1, 2, 5, 6, 7, 8, 9, 10, 12," of which is the 8th field and the core knowledge base.

In the field of Wearable Energy Harvest (see Figures 5(a) and 5(b)), the distribution boundary of related research from 2004 to 2010 is clear. Its core fields are mainly the two of "PHYSICS, MATERIALS, CHEMISTRY" and "MEDICINE, MEDICAL, CLINICAL," and the marginal fields are "ECOLOGY, EARTH, MARINE," "VETERINARY, ANIMAL, SCIENCE," "PSYCHOLOGY, EDUCATION, HEALTH," etc. Compared with the stage of 2000–2010, the research fields involved in Wearable Energy Harvest in the stage of 2011–2020 are clearer, forming a pattern of "PHYSICS, MATERIALS,



(a)

(b)

Figure 5: The dual-map overlay in the field of Wearable Energy Harvest. (a) 2004–2010. (b) 2011–2020.

CHEMISTRY" and "VETERINARY, ANIMAL, SCIENCE" as the core fields. The core knowledge base from 2004 to 2010 isNO. 4 on the right. The core knowledge base is diversified from 2011 to 2020, turning into No.1, No.4, No.6, NO.7, and No.8.

By observing the above overlay maps, it can be found that there is no obvious research bias in the traditional energy expenditure research before 2010, but after 2010, the research gradually begins to focus on research fields such as biomedicine. The research of Wearable Energy Harvest has focused on physical materials and chemistry since the beginning, and the purpose of the research is mainly for medical treatment, which is consistent with the development path traditional energy expenditure has taken. It shows that the initial research and development of Wearable Energy Harvest is to achieve interdisciplinary cooperation, but after 2010, the research of Wearable Energy Harvest has gradually diversified, unlike the traditional energy expenditure research that gradually focuses on a certain field. This shows that the research of Wearable Energy Harvest is moving towards multidirectional interdisciplinary cooperation. By observing the changes of keywords, it can be found that the research result has been used to assist multiple disciplines such as the monitoring of thermal energy in high-intensity sports training.

5. Conclusions

This paper puts forward the problem of research bias on the energy expenditure in the process of human movement. Specifically, we hope to know whether it is single-disciplinary or multidisciplinary research on human movement energy. To achieve a more objective, reliable, convenient, and accurate measurement of energy expenditure in the process of human movement, there has been more and more abundant research, but no scholar has discussed the development trend yet. This paper takes the relevant literature of energy expenditure and sustainable energy harvest from 2000 to 2020 included in the core collection of Web of Science (WOS) as the research object, draws the knowledge graph using CiteSpace tool, sorts and summarizes it from the perspective of metrology, and shows its research trend and bias in different stages. As a result, it is found that the network density of energy expenditure related research is 0.0178 and that of Wearable Energy Harvest related research is 0.0096. Using the keyword burst terms detection technology (Burst analysis) in CiteSpace software, it is found that the overall energy expenditure research mainly focuses on human functions and biology, while Wearable Energy Harvest related research mainly focuses on engineering and material topics. However, through further dual-map overlay analysis it is found that, in traditional energy expenditure research, there is no obvious research bias before 2010, but after 2010 research gradually begins to focus on research fields such as biomedicine. The research of Wearable Energy Harvest has focused on the research of physical materials and chemistry since the beginning, and the results of the research are mainly applied in the medical field. This shows that the initial research and development of Wearable Energy Harvest is to achieve interdisciplinary cooperation in the medical field, but the research of Wearable Energy Harvest has gradually diversified. By observing the changes of keywords, it can be found that the research results have been applied to assist a variety of sports measurement needs such as the monitoring of thermal energy in high-intensity sports training.

However, at the end of this paper, we need to explain the limitations of this paper. First of all, as this paper is a scientometric study of WOS literature, all English literature cannot be considered in the acquisition of data. Therefore, articles retrieved from Google Scholar and other databases are not included in this research. In addition, in data processing, we cannot completely eliminate literature unrelated to the theme. For example, it is found that keywords also appear in some social science articles. Therefore, data cleaning may become the main further work in the future. Future research may focus on the drivers behind the current findings and the historical explanations that have shaped the current phenomenon.

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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