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Postprint: Visual Analysis of International Research Progress and Hotspots in Intermittent Fasting

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Abstract

Purpose: To conduct a visualization analysis of international research hotspots and trends in intermittent fasting over the past decade, providing reference and basis for future research in this field. **Methods:** Existing studies on the topic of IF from the Web of Science Core Collection database between January 2010 and January 2022 were retrieved. Cite Space software was used to analyze the discipline distribution, author and institutional cooperation relationships, high-frequency keywords, emergent cited keywords, and other aspects of the included literature, and to generate relevant mapping visualizations. **Results and Conclusions:** (1) A total of 2,786 documents were ultimately retrieved and included. The publication volume of intermittent fasting-related papers showed a year-by-year increasing trend during 2010-2022, but the global research level remained unbalanced. The country with the highest publication output was the United States, the institution was the University of Illinois, and the most prolific author was Professor Krista A Varady from the University of Illinois. (2) Research hotspots focused on: the relationship with biological rhythms/circadian rhythms; the effects on improving chronic diseases and other conditions; and sensitive genes and related mechanisms. (3) Future research will focus on different populations such as children/adolescents, pregnant women, the elderly, and professional athletes/fitness populations, and explore comparisons of the efficacy and safety of different intermittent fasting intervention modalities in clinical applications, ultimately forming personalized intermittent fasting intervention models and investigating their biological mechanisms.

Full Text

Visualization Analysis of Global Research Progress and Hotspots in Intermittent Fasting

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Abstract Objective: To conduct a visualization analysis of international research hotspots and trends in intermittent fasting over the past decade, providing references and basis for future studies in this field. **Methods:** Literature on intermittent fasting published between January 2010 and January 2022 was retrieved from the Web of Science Core Collection. CiteSpace software was used to analyze discipline distribution, author and institutional collaboration networks, high-frequency keywords, and emergent citation keywords, with corresponding knowledge maps generated. **Results and Conclusions:** (1) A total of 2,786 publications were included. The annual number of intermittent fasting-related papers showed an increasing trend from 2010 to 2022, though global research remains unevenly distributed. The United States led in publication output, with the University of Illinois as the most productive institution, and Professor Krista A. Varady from the University of Illinois as the most prolific author. (2) Research hotspots focused on: the relationship with biological/circadian rhythms; therapeutic effects on chronic and other diseases; and sensitive genes and related mechanisms. (3) Future research should focus on diverse populations including children/adolescents, pregnant women, older adults, and professional athletes/fitness enthusiasts, while exploring comparative effectiveness and safety of different intermittent fasting modalities in clinical applications, ultimately developing personalized intermittent fasting interventions and investigating their biological mechanisms.

[Keywords] intermittent fasting; time restriction; energy restriction; dietary pattern; CiteSpace

Introduction

Intermittent fasting (IF) is a dietary regimen that has garnered widespread attention, defined as an eating pattern that specifies particular feeding windows while maintaining fasting outside these periods. Common approaches include breakfast skipping, time-restricted feeding across three meals, alternate-day fasting, and two-day-per-week fasting protocols. In recent years, intermittent fasting has emerged as an effective dietary intervention for chronic disease preven-

tion and management. Current research indicates that intermittent fasting can trigger cellular responses through alterations in biological rhythms, leading to molecular changes across different energy metabolism pathways and exerting beneficial effects on various chronic conditions including obesity, diabetes, cardiovascular disease, cancer, and neurodegeneration. International research on intermittent fasting has increased annually, with nearly 500 relevant studies indexed in the Web of Science Core Collection in 2021 alone. However, beyond populations with chronic diseases, research remains limited on whether this dietary approach benefits health maintenance in healthy individuals and regarding its safety profile. Therefore, investigating the research background, current status, themes, and hotspots in the intermittent fasting field holds significant importance.

CiteSpace is a widely used visual analysis software for examining structural and temporal patterns in scientific literature. It can transform representative data into knowledge maps through clustering and co-occurrence analysis to detect disciplinary frontiers, guide research direction selection, facilitate knowledge management, and support scientific decision-making. This study retrieved existing research on intermittent fasting from the Web of Science Core Collection and used CiteSpace to generate maps analyzing discipline distribution, author collaboration, institutional collaboration, high-frequency keywords, and emergent citation keywords, aiming to discuss research hotspots and frontiers while providing theoretical foundations for future investigations.

Methods

1.1 Data Sources Literature related to intermittent fasting was retrieved and exported from the Web of Science Core Collection in plain text format, retaining all records and references. The search was conducted on January 26, 2022. Detailed data source information is presented in .

Table 1. Data Source Information

Database	Web of Science Core Collection
Search Terms	Intermittent Fasting OR Time Restricted Feeding OR Time restricted Eating OR Alternate Day Fasting OR Modified Alternate Day Fasting OR Intermittent Energy Restriction OR Intermittent Energy and Carbohydrate Restriction
Search Field	TS=(topic search)

1.2.1 Bibliometric Analysis Microsoft Excel 2013 was used for statistical analysis of data sources and temporal distribution analysis of annual publication volumes.

1.2.2 Visualization Analysis CiteSpace 5.8.R3 was employed for data conversion and visualization analysis, with the time span set from January 2010 to April 2022 and time slice set to “1.” Default software settings were used for database configuration, threshold selection, and term source. Node types were sequentially selected as “author,” “institution,” and “country” for collaborative network analysis; “keyword” and “category” for co-occurrence network analysis; and “citation” and “most-cited author” for co-citation analysis. After data import, conversion, and analysis, visualization maps and tables were generated to interpret co-occurrence and clustering relationships for predicting future research trends.

Results

2.1 Basic Situation Analysis A total of 2,786 publications were retrieved. Analysis of publication years, countries, disciplinary fields, and journals revealed several characteristics:

First, from 2010 to 2022, the annual number of intermittent fasting-related publications generally showed an upward trend, with a slight decline in 2015 and a notable increase during 2020-2021, indicating growing academic attention to intermittent fasting ([Figure 1: see original paper]).

Second, the top ten countries by publication output were: United States (650 papers, 23.5%), China (201 papers, 7.3%), United Kingdom (176 papers, 6.3%), Australia (173 papers, 6.2%), Germany (140 papers, 5.0%), Canada (136 papers, 4.9%), France (110 papers, 3.9%), Brazil (105 papers, 3.8%), Japan (90 papers, 3.2%), and Italy (88 papers, 3.2%). The top three countries by centrality were the United States (0.3), United Kingdom (0.17), and Australia (0.17). These results demonstrate the United States’ leading position in intermittent fasting research. Although China ranked second in publication volume, its total output remains relatively low with low centrality (0.04) ([Figure 2: see original paper],).

Third, the top ten disciplinary fields were: Nutrition & Dietetics (337 papers), Sport Sciences (226 papers), Agriculture (207 papers), Endocrinology & Metabolism (197 papers), Agriculture, Dairy & Animal Science (191 papers), Neurosciences (154 papers), Physiology (137 papers), Science & Technology—Other Topics (137 papers), Multidisciplinary Sciences (134 papers), and Environmental Sciences & Ecology (105 papers). The top three fields by centrality were Sport Sciences (0.31), Nutrition & Dietetics (0.14), and Science & Technology—Other Topics (0.12). The findings indicate that nutrition and sport sciences represent global hotspots, forming a multidisciplinary system centered on these two fields with endocrinology, metabolism, and animal science as peripheral areas ([Figure 3: see original paper],).

Fourth, the top ten journals by publication volume were: *PLOS ONE* (811 pa-

pers), *Proceedings of the National Academy of Sciences of the United States of America* (711 papers), *Science* (574 papers), *Cell Metabolism* (548 papers), *Nature* (526 papers), *American Journal of Clinical Nutrition* (517 papers), *International Journal of Pediatric Obesity* (444 papers), *Obesity* (424 papers), *Physiology & Behavior* (400 papers), and *Cell* (373 papers), with an average impact factor of 20.1, indicating high-quality journal outlets ().

2.2 Visualization Analysis of Authors Based on Price' s Law, the number of core authors was calculated using the formula $N = 0.749 \times (\max)^{1/2}$, where \max represents the maximum number of publications by a single author. Authors with more than N publications were considered core authors. Results identified 11 core authors who published 147 papers collectively, accounting for 5.28% of all retrieved literature. The top three authors were Professor Krista A. Varady (United States, University of Illinois, 26 papers), Professor Satchidananda Panda (United States, Salk Institute, 18 papers), and Professor Mark P. Mattson (United States, Johns Hopkins University, 16 papers) (, [Figure 4: see original paper]). Most authors exhibited extensive collaborative networks, with the top three authors and their teams showing close cooperation, while a few authors remained independent without forming collaborative groups.

2.3 Visualization Analysis of Research Institutions Co-occurrence analysis of research institutions revealed that the top three most productive institutions were the University of Illinois (49 papers), University of Sydney (27 papers), and Johns Hopkins University (25 papers) (, [Figure 5: see original paper]). The top ten institutions demonstrated close collaborative ties, particularly the top three institutions, which showed multiple interconnections in the network map, indicating strong cooperation with other institutions and joint advancement of the intermittent fasting field.

2.4 Co-citation Analysis of Literature Key publications in intermittent fasting were identified through co-citation analysis (). Two highly cited papers (Sutton EF and Mattson MP) and two high-centrality core articles (Harvie MN and Hatori M) were highlighted. Harvie et al. compared the feasibility and effectiveness of intermittent versus continuous energy restriction on weight loss, insulin sensitivity, and other metabolic disease risk markers, finding intermittent energy restriction equally effective as continuous restriction for weight loss and improving insulin sensitivity and other health biomarkers. Hatori et al. investigated nutrient utilization and energy expenditure in mice under isocaloric ad libitum feeding versus time-restricted feeding, demonstrating that time-restricted feeding improved cAMP response element-binding protein, mTOR, and AMPK pathway function, as well as circadian clock oscillations and target gene expression, ultimately altering energy metabolism through these complex signaling networks. The most frequently cited study by Sutton et al. conducted the first clinical trial of early time-restricted feeding aligned with circadian rhythms (6-hour feeding window, dinner before 3 PM) in humans, finding that five weeks of

early time-restricted feeding improved insulin levels, insulin sensitivity, β -cell responsiveness, blood pressure, and oxidative stress in prediabetic men without reducing food intake or causing weight loss.

2.5.1 Keyword Co-occurrence Clustering Analysis **2.5.1.1 Co-occurrence Map.** Analyzing keyword frequency and centrality through co-occurrence mapping can identify research frontiers. Analysis of Web of Science database literature using CiteSpace with keywords as nodes yielded a co-occurrence network with 469 nodes and 1,371 links ([Figure 6: see original paper]). The top five keywords by frequency were weight loss (212 occurrences), intermittent fasting (202), obesity (161), insulin resistance (151), and caloric restriction (127). The top five by centrality were risk (0.11), behavior (0.07), insulin resistance (0.06), time (0.06), metabolism, caloric restriction, and body composition (0.05) ().

2.5.1.2 Keyword Clustering Map. Following co-occurrence analysis, CiteSpace's LLR algorithm clustered keywords into 19 clusters, providing deeper insight into intermittent fasting research themes ([Figure 7: see original paper]). The modularity Q value of approximately 0.7996 indicated significant clustering structure, while the mean silhouette value of approximately 0.9072 suggested reasonable clustering results (). Silhouette values close to 1 reflect high map homogeneity. Based on specific keywords within clusters, research themes were reclassified: clusters #0, 11, and 13 as food intake restriction; clusters #1, 7, 16, and 17 as biological rhythms; clusters #2, 3, 5, 7, 9, and 15 as weight control; clusters #4, 6, 8, 10, and 12 as metabolic and other diseases; and clusters #14, 18, and 19 as mechanism-related research.

2.5.2 Co-citation Clustering and Timeline Analysis Co-citation clustering analysis was performed for 2010-2022 using "Cited references" as nodes with a Top 5 threshold after multiple adjustments, yielding a network map with 469 nodes and 662 links ([Figure 8: see original paper]). Clustering parameters Q and S were 0.80 and 0.91 respectively, indicating reasonable clustering. Nineteen clusters were identified: #0 feed restriction, #1 circadian rhythm, #2 alternate-day fasting, #3 intermittent fasting, #4 resistance, #5 calorie restriction, #6 dietary restriction, #7 suprachiasmatic nucleus, #8 metabolic syndrome, #9 caloric restriction, #10 sleep apnea, #11 animal welfare, #12 mellitus, #13 area restricted search, #14 gene expression, #15 energy balance, #16 restricted feeding, #17 late-night eating, #18 defensive enzymes, and #19 ethnic group.

2.5.3 Burst Keyword Analysis "Burst keywords" refer to terms frequently cited within specific time periods, allowing prediction of research frontiers based on the distribution of strongest citation bursts. CiteSpace extraction of burst keywords in intermittent fasting research yielded Burst values ([Figure 9: see original paper]), where light blue represents the overall study period (2010-2022) and red indicates periods of sudden keyword emergence. From 2010-2022, the

top three burst keywords by intensity were time-restricted feeding (9), suprachiasmatic nucleus (7.11), rat (6.75), growth (6.75), and mice (6.75). Further analysis revealed that from 2010-2014, major burst keywords included suprachiasmatic nucleus, rat, entrainment, plasma, cattle, oscillator, locomotor activity, time, growth, mortality, coronary heart disease, cardiovascular disease, protein, food restriction, temperature, insulin, identification, obstructive sleep apnea, parameter, and growth, focusing on intermittent fasting's effects on biological rhythms and improvements in common chronic diseases including obesity, insulin resistance, cardiovascular disease, and obstructive sleep apnea. From 2015-2018, burst keywords shifted to mice, children, response, restriction, and intermittent energy restriction, indicating emerging research on intermittent fasting effects across different populations and gradual analysis of underlying physiological mechanisms. From 2019-2022, new burst keywords included ketone body, carbohydrate, time-restricted feeding, receptor, and impact, suggesting researchers have developed novel food/energy restriction modalities and begun comparing different approaches while further investigating mechanisms.

Discussion

3.1 Visualization of Research Status Analysis of the most productive countries shows the top five as the United States, China, United Kingdom, Australia, and Germany. The United States, as a global scientific hub, ranks first in both publication volume and centrality. While China ranks second in publication count, its centrality is substantially lower than other top-five countries. Among institutions, nine of the top ten are from developed countries, with six from the United States—all prestigious American universities and research institutes that have formed close collaborative networks. Although China's publication volume entered the top ten, no Chinese institution ranked in the top ten, indicating dispersed and diverse institutional involvement in IF research. Among authors, the top three are all from the United States, with six of ten authors overall being American and the remaining four from Australia (2), Tunisia (Africa, 1), and Qatar (Asia, 1). While one Chinese-named author appears, their affiliation is American, further demonstrating U.S. leadership in intermittent fasting research. The disciplinary scope of intermittent fasting publications has expanded beyond nutrition to form significant intersections with sport sciences, which exhibits the highest centrality, indicating broad research interest and productivity in this domain.

Planning and identifying valuable research topics represents an important challenge for journal development, while journal publications on selected topics substantially enhance theoretical value and widespread dissemination. The fact that top-tier journals including *Science*, *Nature*, and *Cell* have published 574, 526, and 373 articles respectively in this field underscores the novelty and cutting-edge nature of intermittent fasting research.

3.2.1 Research Hotspots Based on high-frequency keywords, hotspot co-occurrence maps, and keyword clustering analysis, intermittent fasting research hotspots concentrate in several areas:

(1) Relationship with Biological/Circadian Rhythms. The circadian clock is an autonomous timing mechanism that allows organisms to anticipate and adapt to environmental rhythms of light, temperature, and food availability. In mammals, the master clock located in the suprachiasmatic nucleus of the hypothalamus and circadian oscillations of clock genes are primarily reset by light, generating circadian rhythms. Peripheral tissues such as liver, adipose tissue, and skeletal muscle also regulate circadian rhythms through non-photic factors including food availability, exercise, and body temperature. Early researchers exploring the relationship between biological rhythms and feeding patterns investigated how dietary changes in feeding/fasting times and patterns coordinate with circadian time windows to regulate transcription of master and peripheral clock genes, thereby influencing metabolism and energy expenditure and ultimately triggering metabolic diseases.

(2) Therapeutic Effects on Common Chronic Diseases. Research over the past decade has demonstrated that intermittent fasting exerts varying degrees of intervention effects on obesity, diabetes, cardiovascular disease, cancer, neurodegenerative brain diseases, and their risk factors. Both animal and human experimental evidence indicate that different intermittent fasting modalities—whether intermittent energy restriction or time-restricted feeding—can reduce risks associated with lipid metabolism, insulin resistance, and other health biomarkers, with improvements proportional to the duration of dietary restriction. However, research also notes that while intermittent fasting reduces body fat, lean mass loss is comparable. Additionally, intermittent fasting improves various cardiovascular risk factors including blood pressure, resting heart rate, HDL and LDL cholesterol, total cholesterol, and reduces systemic inflammation and oxidative stress markers associated with atherosclerosis. Current studies support beneficial effects on these diseases and risk factors, but most are short-term; whether effects can be maintained long-term (>6 months) with guaranteed safety requires further investigation.

Intermittent fasting also positively influences growth of certain tumors including lymphoma, spontaneous tumors, and glioblastoma, while combination with chemotherapy consistently enhances treatment efficacy. However, researchers caution that introducing two-week or longer intermittent fasting periods into clinical trials must consider potential malnutrition-induced immune dysfunction and increased infection susceptibility, necessitating more rigorous and personalized study designs. Furthermore, animal models demonstrate that intermittent fasting exerts beneficial effects on the nervous system through multiple mechanisms, preventing seizures and delaying Alzheimer's and Parkinson's disease progression, though clinical controlled trial data remain lacking and require long-term follow-up.

(3) Therapeutic Effects on Other Diseases. Co-citation keyword clus-

tering timelines reveal that sleep apnea has become a recent research hotspot. Obstructive sleep apnea is closely associated with increased risks of metabolic syndrome, cardiovascular disease, and type 2 diabetes, with overweight and obesity considered the most important risk factors. Studies indicate that different time-restricted feeding windows (6-hour/4-hour) can reduce sleep apnea risk, though alternate-day fasting for 24 weeks observed insufficient weight loss for significant risk improvement. Additionally, intermittent fasting demonstrates beneficial effects on immune system diseases, reducing oxidative stress markers and inflammation while decreasing tissue damage.

(4) Sensitive Genes and Related Mechanisms. International research emphasizes exploration of mechanisms through which intermittent fasting influences health and disease, including understanding of gene expression in dietary intervention clinical studies through cutting-edge genomics and transcriptomics technologies. Studies show intermittent fasting promotes fat reduction by increasing hypothalamic neuropeptide Y gene expression and upregulating Fsp27/Cidec gene expression in white adipose tissue. Intermittent fasting also modulates expression of sensitive genes involved in cellular metabolism (SIRT1 and SIRT3) and antioxidant responses (mitochondrial transcription factor A, manganese superoxide dismutase, and nuclear factor erythroid 2-related factor 2), thereby exerting protective effects against metabolic disorders in chronic disease patients.

3.2.2 Research Frontiers Analysis of keyword timeline views and burst keyword visualization maps reveals several research frontiers:

(1) Changing Study Populations. Research has evolved from focusing on intermittent fasting effects in obese and diabetic populations to investigating children/adolescents, pregnant women, older adults, and professional athletes/fitness enthusiasts. For athletes and fitness populations, researchers are exploring intermittent fasting's effects on athletic performance (including anaerobic and aerobic capacity) while improving body composition. Although current research remains limited, these developments reflect present and future trends toward more personalized approaches addressing diverse population needs.

(2) Evolution of Fasting Modalities. Intermittent fasting centers on adjusting feeding times within days or weeks. Burst keywords including intermittent energy restriction and time-restricted feeding (TRF) confirm that different fasting patterns constitute core research frontiers. TRF restricts food intake to daily windows of 8 hours or less, with variations including 16-hour fasting/8-hour feeding, 20-hour fasting/4-hour feeding, or similar protocols. Beyond examining single modality effects, comparative studies between different fasting patterns—such as alternate-day fasting, time-restricted feeding, intermittent energy restriction, and ketogenic diets—or combined interventions (multiple fasting method combinations, fasting combined with medication, fasting combined with exercise) represent important future research directions for health promotion and disease recovery.

(3) Further Mechanistic Exploration. Ketone body (2019-2020), receptor (2020-2022), and impact (2020-2022) have emerged as burst keywords in recent years. During fasting, the liver converts fatty acids into ketone bodies that provide crucial energy for many tissues, particularly the brain. Beyond energy provision, ketone bodies and their receptor level changes influence expression and activity of molecules including PGC-1 α , NAD⁺, and ADP, exerting profound effects on systemic metabolism. Additionally, research on insulin-related receptors, energy metabolism signaling pathway molecules, autophagy-related protein expression, lipidomics, proteomics, and gut microbiota mechanisms represents cutting-edge investigation.

4. Summary and Research Outlook

This study analyzed international literature from 2010-2022 in the Web of Science only, without including Chinese database literature. However, global research demonstrates increasing interest in intermittent fasting, with important and high-centrality publications primarily from Europe and America, reflecting global research imbalance.

Current research has established broad benefits of different intermittent fasting modalities for obesity, diabetes, cardiovascular disease, cancer, neurological disorders, and other health conditions. Future research should focus on personalized protocols for diverse populations including children/adolescents, women, older adults, and athletes. Beyond evaluating which intermittent fasting modality yields superior effects in target populations, studies must further examine safety across different groups. Based on established efficacy and safety, dose-response relationships should be determined, including optimal intervention durations and persistence of effects after discontinuation. Additionally, most current research involves short-term interventions; whether multi-year intermittent fasting requiring substantial dietary changes yields additional benefits remains an open question.

Although this study did not analyze Chinese research data, intermittent fasting research in China remains in its infancy, lacking clinical human experimental data. Chinese dietary patterns are more complex than Western populations, presenting challenges for clinical research. Against the backdrop of the “Healthy China” national strategy, future research should integrate epidemiological data, longevity population dietary characteristics, and human intermittent fasting protocol studies under different modalities. Chinese research should focus not only on large-scale clinical trial design but also on combining fasting effects with acceptable dietary approaches (e.g., circadian rhythm-aligned intermittent fasting protocols) to improve compliance and success rates. Finally, by better understanding molecular mechanisms through which intermittent fasting affects various cell types and organ systems, novel personalized preventive and therapeutic interventions can be developed for diverse diseases and population health

needs.

Author Contributions: GUO Xian conceptualized the study, drafted and revised the manuscript, controlled quality, and takes overall responsibility; ZHOU Yan-bing conducted literature retrieval, data analysis, and figure/table preparation; LIU Jing-ying and MU Jin-hao performed data analysis and figure/table preparation; CAO Hui conducted data analysis. All authors approved the final manuscript.

Conflict of Interest: The authors declare no conflict of interest.

References

- [1] ENRIQUEZ G A, SAN M M I, GARICANO V E, et al. Effectiveness of an intermittent fasting diet versus continuous energy restriction on anthropometric measurements, body composition and lipid profile in overweight and obese adults: a meta-analysis[J]. *Eur J Clin Nutr*, 2021, 75(7):1024-1039.
- [2] SANTOS H O, GENARIO R, MACEDO R C O, et al. Association of breakfast skipping with cardiovascular outcomes and cardiometabolic risk factors: an updated review of clinical evidence[J]. *Crit Rev Food Sci Nutr*, 2022, 62(2):466-474.
- [3] MORO T, TINSLEY G, LONGO G, et al. Time-restricted eating effects on performance, immune function, and body composition in elite cyclists: a randomized controlled trial[J]. *J Int Soc Sports Nutr*, 2020, 17(1):65.
- [4] DE CABO R, MATTSON M P. Effects of intermittent fasting on health, aging, and disease[J]. *N Engl J Med*, 2019, 381(26):2541-2551.
- [5] SCHOLTENS E L, KREBS J D, CORLEY BT, et al. Intermittent fasting 5:2 diet: What is the macronutrient and micronutrient intake and composition?[J]. *Clin Nutr*, 2020, 39(11):3354-3360.
- [6] HALPERN B, MENDES T B. Intermittent fasting for obesity and related disorders: unveiling myths, facts, and presumptions[J]. *Arch Endocrinol Metab*, 2021, 65(1):14-23.
- [7] LEVY E, CHU T. Intermittent fasting and its effects on athletic performance: A review[J]. *Curr Sports Med*, 2019, 18(7):266-269.
- [8] GABEL K, VARADY K A. Intermittent fasting and muscle lipid metabolism[J]. *J Clin Endocrinol Metab*, 2021, 106(3):e1468-e1470.
- [9] CHEN C. Science mapping: A systematic review of the literature[J]. *Journal of Data and Information Science*, 2017, 2(2):1-40.
- [10] CHEN Y, CHEN C M, LIU Z Y, et al. The methodological function of

CiteSpace Knowledge graph[J]. *Studies in Science of Science*, 2015, 33(2):242-253.

[11] HARVIE M N, PEBINGTON M, MATTSON M P, et al. The effects of intermittent or continuous energy restriction on weight loss and metabolic disease risk markers: a randomized trial in young overweight women[J]. *International Journal of Obesity*, 2011, 35(5):714-727.

[12] HATORI M, VOLLMERS C, ZARRINPAR A, et al. Time-Restricted Feeding without Reducing Caloric Intake Prevents Metabolic Diseases in Mice Fed a High-Fat Diet[J]. *Cell Metabolism*, 2012, 15(6):848-860.

[13] SUTTON E F, BEYL R, EARLY K S, et al. Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes[J]. *Cell Metab*, 2018, 27(6):1212-1221.

[14] ZHONG D, LUO S, ZHENG L, et al. Epilepsy occurrence and circadian rhythm: A bibliometrics study and visualization analysis via CiteSpace[J]. *Front Neurol*, 2020, 11:984.

[15] LUO H, CAI Z, HUANG Y, et al. Study on pain catastrophizing from 2010 to 2020: A bibliometric analysis via CiteSpace[J]. *Front Psychol*, 2021, 12:759347.

[16] LI Q, YU Y, SHI Q F. A comparative analysis of disruptive innovation research at home and abroad based on knowledge map[J]. *Science and Technology Management Research*, 2020, 40(15):9-19.

[17] RUAN X F, ZHANG J J, DU P, et al. Visual Analysis of Nonalcoholic Fatty Liver Disease Treatment Based on CiteSpace software[J]. *Mil Med J S Chin*, 2019, 33(12):815-822.

[18] FAN S J, BAI Y, XU J, et al. A preliminary study on the mode of literature metrology assisted topic selection planning in medical journals[J]. *Chinese Journal of Scientific and Technical Periodicals*, 2021, 32(11):1460-1466.

[19] RALPH M R, FOSTER R G, DAVIS F C, et al. Transplanted suprachiasmatic nucleus determines circadian period[J]. *Science*, 1990, 247(4945):975-978.

[20] CHALLET E, MENDOZA J, DARDENTE H, et al. Neurogenetics of food anticipation[J]. *Eur J Neurosci*, 2009, 30(9):1676-1687.

[21] KASUKAWA T, SUGIMOTO M, HIDA A, et al. Human blood metabolite timetable indicates internal body time[J]. *Proc Natl Acad Sci U S A*, 2012, 109(37):15036-15041.

[22] YOSHIDA C, SHIKATA N, SEKI S, et al. Early nocturnal meal skipping alters the peripheral clock and increases lipogenesis in mice[J]. *Nutr Metab (Lond)*, 2012, 9(1):78.

[23] MATTSON M P, ALLISON D B, FONTANA L, et al. Meal frequency and

timing in health and disease[J]. *Proc Natl Acad Sci U S A*, 2014, 111(47):16647-16653.

[24] CHUNG H, CHOU W, SEARS D D, et al. Time-restricted feeding improves insulin resistance and hepatic steatosis in a mouse model of postmenopausal obesity[J]. *Metabolism*, 2016, 65(12):1743-1754.

[25] CHAIX A, ZARRINPAR A, MIU P, et al. Time-restricted feeding is a preventative and therapeutic intervention against diverse nutritional challenges[J]. *Cell Metab*, 2014, 20(6):991-1005.

[26] GILL S, PANDA S. A smartphone app reveals erratic diurnal eating patterns in humans that can be modulated for health benefits[J]. *Cell Metab*, 2015, 22(5):789-798.

[27] FURMLI S, ELMASRY R, RAMOS M, et al. Therapeutic use of intermittent fasting for people with type 2 diabetes as an alternative to insulin[J]. *BMJ Case Rep*, 2018, 2018:bcr2017221854.

[28] RONA A, ROBERTSON T M, DENISE R M, et al. A pilot feasibility study exploring the effects of a moderate time-restricted feeding intervention on energy intake, adiposity and metabolic physiology in free-living humans[J]. *Journal of Nutritional Science*, 2018, 7:e22.

[29] HARVIE M, WRIGHT C, PEGINGTON M, et al. The effect of intermittent energy and carbohydrate restriction v. daily energy restriction on weight loss and metabolic disease risk markers in overweight women[J]. *Br J Nutr*, 2013, 110(8):1534-1547.

[30] MOST J, GILMORE L A, SMITH S R, et al. Significant improvement in cardiometabolic health in healthy nonobese individuals during caloric restriction-induced weight loss and weight loss maintenance[J]. *Am J Physiol Endocrinol Metab*, 2018, 314(4):E396-E405.

[31] DONG T A, SANDESARA P B, DHINDSA D S, et al. Intermittent fasting: A heart healthy dietary pattern?[J]. *Am J Med*, 2020, 133(8):901-907.

[32] WILKINSON M J, MANGOOGIAN E, ZADOUTIAN A, et al. Ten-hour time-restricted eating reduces weight, blood pressure, and atherogenic lipids in patients with metabolic syndrome[J]. *Cell Metab*, 2020, 31(1):92-104.

[33] MORO T, TINSLEY G, BIANCO A, et al. Effects of eight weeks of time-restricted feeding (16/8) on basal metabolism, maximal strength, body composition, inflammation, and cardiovascular risk factors in resistance-trained males[J]. *J Transl Med*, 2016, 14(1):290-299.

[34] NENCIONI A, CAFFA I, CORTELLINO S, et al. Fasting and cancer: molecular mechanisms and clinical application[J]. *Nat Rev Cancer*, 2018, 18(11):707-719.

[35] ELSAKKA A, BARY M A, ABDELZAHER E, et al. Management of Glioblastoma Multiforme in a Patient Treated With Ketogenic Metabolic Ther-

apy and Modified Standard of Care: A 24-Month Follow-Up[J]. *Front Nutr*, 2018, 5:20.

[36] LEE C, RAFFAGHELLO L, BRANDHORST S, et al. Fasting cycles retard growth of tumors and sensitize a range of cancer cell types to chemotherapy[J]. *Sci Transl Med*, 2012, 4(124):124r-127r.

[37] SHI Y, FELLE-BOSCO E, MARTI T M, et al. Starvation-induced activation of ATM/Chk2/p53 signaling sensitizes cancer cells to cisplatin[J]. *BMC Cancer*, 2012, 12:571.

[38] LONGO V D, MATTSON M P. Fasting: molecular mechanisms and clinical applications[J]. *Cell Metab*, 2014, 19(2):181-192.

[39] LIU Y, CHENG A, LI Y J, et al. SIRT3 mediates hippocampal synaptic adaptations to intermittent fasting and ameliorates deficits in APP mutant mice[J]. *Nat Commun*, 2019, 10(1):1886.

[40] MATTSON M P, ARUMUGAM T V. Hallmarks of brain aging: Adaptive and pathological modification by metabolic states[J]. *Cell Metab*, 2018, 27(6):1176-1199.

[41] ST-ONGE M P, SHECHTER A. Sleep disturbances, body fat distribution, food intake and/or energy expenditure: pathophysiological aspects[J]. *Horm Mol Biol Clin Investig*, 2014, 17(1):29-37.

[42] CIENFUEGOS S, GABEL K, KALAM F, et al. The effect of 4-h versus 6-h time restricted feeding on sleep quality, duration, insomnia severity and obstructive sleep apnea in adults with obesity[J]. *Nutr Health*, 2021:2048226325.

[43] KALAM F, GABEL K, CIENFUEGOS S, et al. Alternate day fasting combined with a low carbohydrate diet: Effect on sleep quality, duration, insomnia severity and risk of obstructive sleep apnea in adults with obesity[J]. *Nutrients*, 2021, 13(1):211-219.

[44] CIGNARELLA F, CANTONI C, GHEZZI L, et al. Intermittent fasting confers protection in CNS autoimmunity by altering the gut microbiota[J]. *Cell Metab*, 2018, 27(6):1222-1235.

[45] FITZGERALD K C, VIZTHUM D, HENRY-BARRON B, et al. Effect of intermittent vs. daily calorie restriction on changes in weight and patient-reported outcomes in people with multiple sclerosis[J]. *Mult Scler Relat Disord*, 2018, 23:33-39.

[46] LILJA S, STOLL C, KRAMMER U, et al. Five days periodic fasting elevates levels of longevity related christensenella and sirtuin expression in humans[J]. *Int J Mol Sci*, 2021, 22(5):2331-2345.

[47] MITCHELL S J, BERNIER M, MATTISON J A, et al. Daily fasting improves health and survival in male mice independent of diet composition and calories[J]. *Cell Metab*, 2019, 29(1):221-228.

- [48] GOTTHARDT J D, VERPEUT J L, YEOMANS B L, et al. Intermittent fasting promotes fat loss with lean mass retention, increased hypothalamic norepinephrine content, and increased neuropeptide Y gene expression in diet-induced obese male mice[J]. *Endocrinology*, 2016, 157(2):679-691.
- [49] KARBOWSKA J, KOCHAN Z. Intermittent fasting up-regulates Fsp27/Cidec gene expression in white adipose tissue[J]. *Nutrition*, 2012, 28(3):294-299.
- [50] MADKOUR M I, T EL-SERAFI A, Jahrami H A, et al. Ramadan diurnal intermittent fasting modulates SOD2, TFAM, Nrf2, and sirtuins (SIRT1, SIRT3) gene expressions in subjects with overweight and obesity[J]. *Diabetes Res Clin Pract*, 2019, 155:107801.
- [51] ATHANSIAN C E, LAZAREVIC B, KRIEGEL E R, et al. Alternative diets among adolescents: facts or fads?[J]. *Curr Opin Pediatr*, 2021, 33(2):252-259.
- [52] JEBEILE H, GOW M L, LISTER N B, et al. Intermittent energy restriction is a feasible, effective, and acceptable intervention to treat adolescents with obesity[J]. *J Nutr*, 2019, 149(7):1189-1197.
- [53] FLANAGAN E W, KEBBE M, SPARKS J R, et al. Assessment of eating behaviors and perceptions of time-restricted eating during pregnancy[J]. *J Nutr*, 2022, 152(2):475-483.
- [54] DARMAUN D. Maternal intermittent fasting during pregnancy: a translational research challenge for an important clinical scenario[J]. *Clin Sci (Lond)*, 2021, 135(17):2099-2102.
- [55] HENDERSON Y O, BITHI N, LINK C, et al. Late-life intermittent fasting decreases aging-related frailty and increases renal hydrogen sulfide production in a sexually dimorphic manner[J]. *Geroscience*, 2021, 43(4):1527-1554.
- [56] ANTON S, EZZATI A, WITT D, et al. The effects of intermittent fasting regimens in middle-age and older adults: Current state of evidence[J]. *Exp Gerontol*, 2021, 156:111617.
- [57] CORREIA J M, SANTOS I, PEZARAT-CORREIA P, et al. Effects of intermittent fasting on specific exercise performance outcomes: A systematic review including meta-analysis[J]. *Nutrients*, 2020, 12(5):1390-1411.
- [58] NAHARUDIN M, YUSOF A. The effect of 10 days of intermittent fasting on Wingate anaerobic power and prolonged high-intensity time-to-exhaustion cycling performance[J]. *Eur J Sport Sci*, 2018, 18(5):667-676.
- [59] ZHANG X, ZOU Q, ZHAO B, et al. Effects of alternate-day fasting, time-restricted fasting and intermittent energy restriction DSS-induced on colitis and behavioral disorders[J]. *Redox Biol*, 2020, 32:101535.
- [60] VOSS M, WAGNER M, VON METTENHEIM N, et al. ERGO2: A prospective, randomized trial of calorie-restricted ketogenic diet and fasting in addition

to reirradiation for malignant glioma[J]. *Int J Radiat Oncol Biol Phys*, 2020, 108(4):987-995.

[61] DAS S, MCCREARY J, SHAMIM S, et al. Reversal of severe hypertriglyceridemia with intermittent fasting and a very-low-carbohydrate ketogenic diet: a case series[J]. *Curr Opin Endocrinol Diabetes Obes*, 2020, 27(5):308-311.

[62] NEWMAN J C, VERDIN E. β -Hydroxybutyrate: A signaling metabolite[J]. *Annu Rev Nutr*, 2017, 37:51-76.

[63] SAAD R. Effects of intermittent fasting on health, aging, and disease[J]. *N Engl J Med*, 2020, 382(18):1773.

[64] BRUNO N E, NWACHUKWU J C, HUGHES D C, et al. Activation of *Crtc2/Creb1* in skeletal muscle enhances weight loss during intermittent fasting[J]. *FASEB J*, 2021, 35(12):e21999.

[65] VASCONCELOS A R, DA P A, KINOSHITA P F, et al. Toll-like receptor 4 signaling is critical for the adaptive cellular stress response effects induced by intermittent fasting in the mouse brain[J]. *Neuroscience*, 2021, 465:142-153.

[66] HARNEY D J, CIELESH M, CHU R, et al. Proteomics analysis of adipose depots after intermittent fasting reveals visceral fat preservation mechanisms[J]. *Cell Rep*, 2021, 34(9):108804.

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