Review Article

Yoga, bioenergetics and eating behaviors: A conceptual review

Arnulfo Ramos-Jiménez, Abraham Wall-Medrano, Rocío I Corona-Hernández, Rosa P Hernández-Torres[1]

Department of Basic Sciences, Biomedical Sciences Institute, Autonomous University of Ciudad Juarez, [1]School of Physical Education and Sport Sciences, Autonomous University of Chihuahua, Ciudad Juarez Chihuahua, México.

Address for correspondence: Dr. Arnulfo Ramos-Jiménez, Laboratorio de Fisiología del Ejercicio, edificio Z planta baja Instituto de Ciencias Biomédicas, Universidad Autónoma de Ciudad Juárez Anillo Envolvente del Pronaf y Estocolmo S/N Zona Pronaf, Cd. Juárez, Chih. C.P. 32310 México.
E-mail: arnulforaji@yahoo.com

ABSTRACT

Yoga is an ancient oriental discipline that emerged from mystical and philosophical concepts. Today it is practiced in the west, partly due to the promotion of its benefits to improve the lifestyle and overall health. As compared to non-*Hatha Yoga* (HY) practitioners, healthier and better-eating patterns have been observed in those who practice it. Agreement with the brought benefits, *HY* can be used as a therapeutic method to correct abnormal eating behaviors (AEB), obesity, and some metabolic diseases. However, the energy expenditure during traditional protocols of *HY* is not high; hence, it is not very effective for reducing or maintaining body weight or to improve cardiovascular conditioning. Even so, several observational studies suggest significant changes in eating behaviors, like a reduction in dietary fat intake and increments in that of fresh vegetables, whole grains and soy-based products, which in turn may reduce the risk for cardiovascular diseases. Given the inconsistency of the results derived from cross-sectional studies, more case–control studies are needed to demonstrate the efficacy of *HY* as an alternative method in the clinical treatment of disordered eating and metabolic diseases.

Key words: Bioenergetics; complementary medicine; eating disorders; exercise; lifestyles.

INTRODUCTION

Yoga originated around 3000 years B.C., under mystical and philosophical concepts in the Hindu tradition. It was transmitted exclusively from teacher to student up until the mid-19th century. Its principles rest in metaphysics, which are hard to understand in Western countries and for those who do not practice it. Some authors, who have gone deep into its study and practice, have tried to explain it. Etymologically, yoga means to "add," "join," "unite" or "attach" (*Sanskrit, ioga*) where the body (*anga*), mind (*chitta*), emotions and the soul (*atma* or *atman*). A complete explanation of this ancient discipline was given by Eliade[1] in his treatise *"Yoga, immortality and freedom,"* and defined as *a collection of specific techniques to seek a truth hidden in the silence and in the inner calm of people, a fundamental truth which enables one to free the soul from false reality*, a state of *liberation of the waves of thought* or ecstasy ("*Samadhi*"; *Sanskrit, sam o samialk [complete] and* ādhi *[mentally absorbed]*)."

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Currently, there are several categories of Yoga. The one practiced in Western societies is an integral Yoga described by Patañjali (II century B.C.).[2] He condenses in his *Yoga sūtras,* a collection of aphorisms in a Buddhist/Hindi text or manual, the traditions and practices of ancient and contemporary practitioners (yogis). This type of yoga was brought to the American continent by Swami Vivekananda at the end of the 19th century (1894–1896) and was scientifically and philosophically enriched by Eliade.[1] However, through the years Yoga has undergone many transformations and adaptations, thereby changing its original principles and fundamentals.[3] As opposed to the traditional practice, physical focus on Yoga became very popular in the west beginning in the second half of the 20th century and is often referred simply as to *Hatha Yoga* (*HY)*.

Hatha Yoga refers to a set of physical (Asanas) and mental exercises, designed to align the body and mind, in such way the vital energy *(prāṇa)* can flow freely. It consists of respiratory exercises (*prányáyámas* or *shatkarma*), physical stretching postures, isometric force, balance, relaxation (*yoganidra*) and concentration (*dharana*), whose purpose is to ensure that *Anga* is fit for meditation (*dhyana*). These elements are conducive to a unique level of consciousness and self-realization, leading to liberation (*kaivalya*) of the self (*atman*).[2]

Hatha Yoga reduces stress,[4] improves overall physical fitness and reduces some risk factors for cardiovascular diseases.[5-7] Other health effects include prevention of cardiac arrhythmias,[8] hypertension,[9] insomnia,[10] cardiopulmonary disorders,[11] depression and anxiety, epilepsy, cancer, menopause symptoms[12] and chronic back pain.[13] That is why it is adopted as part of a healthy lifestyle or as a therapeutic resource in alternative medicine.[14,15] To give just an example, Ross *et al*.,[16] postulate that the frequency of yoga practice at home favorably predicted ($P < 0.001$): Mindfulness, subjective well-being, healthy body mass index (BMI), fruit and vegetable consumption, vegetarian status and vigor. Moreover, specifics components of yoga practice (e.g., physical poses, breath work, meditation, and study of yoga philosophy) improve health behaviors or lifestyle-related health conditions.

However, its benefits in other physical and mental disturbances remain not conclusive, and even harmful effects have even been reported when practiced incorrectly, by unskilled people or disabled.[17,18] Anyhow, *HY* should be considered as a preventive strategy for improving several metabolic conditions although its utility in complementary medicine, as compared with conventional medical therapies, is under-recognized by the health care community.[19] Lastly, yoga is also a lifestyle, so the physiological events are complemented with other environmental factors such as the change in eating patterns. Here's a conceptual review of this subject, with particular emphasis on the changes in eating behaviors (EBs) and "bioenergy" (BE) management in yogis and the practice of *HY* as a mean to improve lifestyle and eating patterns in nonyoga practitioners.

METHODOLOGY

The issues to be addressed in the following sections of this critical review, derived from a systematic search for information on 5 databases (Medline [PubMed], Lilacs [Scielo], Latindex, Science direct, Google Scholar) are recognized in the field of yoga and its health impacts. The following Medical Subject Headings (*MeSH, Tree number*) were used in combination with "*Yoga*" and "*HY*" with the purpose of gathering and evaluating judiciously: Energy metabolism (EM) (MESH: G03.495.335), energy expenditure (EE) (MESH: G03.495.335), food (MESH: J02.500), diet (MESH: G07.610.240), eating disorders (ED) (MESH: F03.375), EBs (MESH: F01.145.113.547, F01.145.407), eating (MESH: G07.610.593.260, G07.700.620.260, G10.261.326.240), anorexia nervosa (MESH: F03.375.100), bulimia nervosa (MESH: F03.375.250) and binge eating. Anticipating the specificity and unexplored nature of certain topics, the information gathered from these databases was complemented with certain unpublished findings from the authors.

YOGA BIOENERGETICS

Within the philosophy of yoga, the body's energy is studied from a more subtle and difficult way to measure, which plays a part on the control of total energy intake (TEI) and total energy expenditure (TEE). So, a more holistic view of energy balance has to be addressed, here referred to as BE or *kundalini* energy.

With the purpose of achieving the desired freedom (*kaivalya*) of the inner self (*atman*), the yogi tries to control the body's energy centers (*kundalini-chakras*) and senses (*jnanendriya*). The *kundalini* energy comes in three states: The common dormant, the aroused and the awakened states. When dormant, one's spiritual understanding is restricted, and everything is perceived and interpreted according to a mundane and selfish perspective. When aroused, it gives a sudden temporary state of spiritual insight and spiritual energy, but it is not stable. Only the awakened *kundalini* energy gives stable transformations of consciousness and progressive realization.[20]

The yogi is not interested in developing physical strength or athletic abilities, at least not in the way they are perceived in the West. The yogi is only interested in the control of its body for the development of *atman*. To achieve this bioenergetic level, the yogi integrates abstinence (*yamas*), purity, moderation, and modesty (*niyamas*) into his/her daily life, and even some dietary[21] and physical activity aspects[22,23] rely on these principles. Therefore, it is somewhat meaningless for the yogi to seek athletic ability using *kundalini* energy. Nevertheless, some studies using subjective methods to study the effect of *HY* in BE demonstrate that systematic practice improves the yogi`s vitality and perception of its own physical condition, social functioning and quality of life.[24] Also, because of the nature of physical exercises (*Asanas*) performed in *HY*, it is common to find exceptional physical abilities in trained yogis especially in muscular flexibility, strength[25] and stress control.[4,26]

Given the mystical-philosophical roots of *HY*, the contemporary yogi continues to strive for something more than merely physical and mental health.[27] However, due to the benefits of overall health, it is important to continue to study in detail the subject of BE of *HY* as compared to other exercise protocols.[23] In the following paragraphs, only the "measurable" energetic aspects are evaluated from the TEE point of view and in terms of changes in EBs which in turn modify TEI. On the metaphysical aspect of *HY*, psychology and anthropology can provide better arguments and theories, an aspect that escapes the purpose of this review. However, there are very complete comprehensive reviews on this topic.[1,28,29]

YOGA AND ENERGY EXPENDITURE

Scientific studies on EM are focused on measuring TEI or TEE. The latter is generally measured at rest (resting energy expenditure [REE]) or at sleep (basal, basal energy expenditure) or as a result of different pathological, pharmacological, physiological or nutritional modifications.[30] At cellular and molecular levels, many ionic, enzymatic, biosynthetic and genetic mechanisms are involved with either TEI or TEE. Consequently, several metabolic indicators, forms of measurement and equations to estimate the study of the body`s energy balance and body weight control[31] have been generated.

However little or nothing is known about TEE during activation of *kundalini* energy. Recently Goshvarpour *et al*.[32,33] reported chaotic heart rate signals as a result of *kundalini* meditation, which are quite different from those observed in Chinese *Chi* meditation. From a physiological perspective, meditation is a physiological state of demonstrated reduced metabolic activity – different from sleep – that elicits physical and mental relaxation. Therefore, the EE involved in *kundalini* meditation is REE. Also, while performing *HY (Asanas)* the physical intensity measured as consumption of oxygen (VO_2) or metabolic equivalents (METs), is low; in fact, it is lesser than that expended in other physical activities such as walking, jogging, running, cycling and swimming. Clay *et al*.,[34] while studying young adults, found that the METs while performing *HY* (*asanas* + *pranayamas* + *dhyana*) is 53% less than jogging at 3.5 mill/h (2.2 vs. 3.3 METs); Hagins *et al*.,[35] found that it is similar to walking at 2 mill/h (~2.5 METs), and that asanas performed in sitting or lying position expend lesser energy (1.5 METs) than those performed in standing positions (2.3 METs).

On the other hand, Danucalov *et al*.,[36] and Wallace and Benson,[37] found relevant reductions in VO_2 during meditation and relaxation (*yoganidra*) as compared to resting conditions (~2.6 vs. 4.0 ml of O_2/kg of body mass/min). All of the above indicates that common protocols of *HY* are characterized as being of very low intensity, with little possibility of cardiovascular benefits. However, there is a possibility to improve the physical performance, hemodynamic function and increased cardio-respiratory reserve in *HY*, in spite of the low exercise stimulus; this as a consequence of concerted physical and mental events, such as local muscular adaptation during some physically intense asanas, breathing exercises (*Prāṇāyāma*) and psycho-physiological control (concentration).[38] It is noteworthy that *asanas* performed at different intensities may increase TEE up to 3.0 kcal/min while that expended on breathing exercises or during meditation is 2.0 and 1.4 kcal/min, respectively. In view of these arguments, from a cardiopulmonary conditioning standpoint, it is necessary to include complementary aerobic exercises into the *HY* routine or to perform it with greater intensity.[6,7]

Sun Salutation (*Surya Namaskar*) is one of the oldest yoga exercises known to man and is one of the most popular and well-acclaimed yoga postures.[39] It has been practiced for centuries and consists of 10–12 different postures[40] which are preferably performed at dawn.[41,42] Each posture counteracts the preceding one producing a balance between flexion and extension with synchronized breathing and aerobic activity.[39] The posture cycle can be repeated several times and at different velocities in the same workout, thereby placing more emphasis on increase of TEE and cardiovascular conditioning. However, *Surya Namaskar* requires, for its proper performance, an adequate amount of flexibility and muscular strength which is why the studies of this practice have only been done on people who are young or physically fit.[41] Further, the execution must be rhythmic in nature, with each posture and its transition being executed in smooth cadence, and the postures must be performed with minimal jerks or ungainly movements.[40]

The physical intensity of *Surya Namaskar* is between 3.6 and 9.5 METs. Mody,[41] reported VO_2 of 26 ml/kg/min during each round, resulting in an TEE of 234 Kcal during a 30 min session for a 60 kg individual. That EE is enough to maintain body weight or to improve aerobic conditioning.[43] In view of this and in accordance with its intensity and TEE, *Surya Namaskar* is classified as a moderate-to-high intensity exercise that can be used, when performed at high rhythms, as a form of cardiopulmonary conditioning for people who are young or physically fit. Furthermore, it could be included in contemporary *HY* sessions. In order to demonstrate that *Surya Namaskar* is a safe exercise, Omkar *et al*.,[40] studied the force and moment effects on specific joints (wrist, elbow, shoulder, hip, knee and ankle) during practice of *Surya Namaskar*. Using a mathematical model, they found that none of the joints were overstressed during *Surya Namaskar* practice, and concluded that the joints involved are subjected to submaximal loadings as

compared to more high impact exercises for which the EE is comparable. "This is of particular importance for older people and for those who have functional limitations in performing aerobic training."[19,44]

Other alternatives for increasing TEE and cardiovascular conditioning while performing *HY*, is increasing its intensity and duration of the sessions or adding complementary aerobic and muscular resistance exercises.[6,7] Ray *et al*.,[45] also demonstrated improved aerobic capacity and decreased perceived exertion after the maximal exercise of *HY*. Ramos-Jiménez *et al*.,[7] found that 11 weeks of an intensive *HY* program, under a more intense protocol than usual performed by trained practitioners of yoga, produced an increase in VO_2 max (~3 ml/kg/min), a decrease in body fat (~1.5 kg), systolic blood pressure (~5.5 mmHg) and diastolic blood pressure (~3 mmHg), as well as a weekly TEE of ~1000 kcal. So, intense *HY* would fulfill the minimum guidelines of the American College of Sports Medicine for maintaining body weight.[43]

In conclusion, given the growing popularity of *HY*, it can be considered as an alternative to increase the level of physical activity. However, it is recommended to increase the intensity and duration and to include alternative exercises like *Surya Namaskar* to ensure a maximal TEE and cardiovascular fitness.[43] For instance, the practice of asanas could be an optimal method for preserving the physical function in older people if exercise series are adapted to muscle and join performance[46] as demonstrated in the *Yoga Empowers Senior Study*.[44] Lastly, the *Surya Namaskar* could be a better alternative for cardiovascular health, but this should be practiced with caution, especially in people with low fitness levels.

YOGA AND EATING BEHAVIOR

The dietary pattern of a person is one of the most important predictors of health risk. There is substantial evidence that a diet rich in fruits, vegetables, whole grain cereals, lean meat, and fish are inversely associated with the risk of chronic illnesses like cardiovascular disease, cancer, or diabetes.[21,47] However, the food selection is a complex behavioral process since individuals and groups make dietary choices based on food familiarity, availability, cost, cultural norms, taste preferences, health, and convenience, among other factors.[48-51] The current environment of modern food, with the wide variety of food options, can be so large that it can become difficult to identify a consistent food pattern among people.

Healthy eating can also be considered a practice to seek for and attain harmonic body/mind balance. According to Yoga philosophy, there are intimate connections of diet with mind, and foods have an unknown subtle essence difficult to prove through modern scientific methods. According to Yoga, there are three types of foods: *Sattvic*, *Rajasic* and *Tamasic*.

- The *Sattvic* diet (pure and balanced) is believed to increase energy, produces happiness, calmness, and mental clarity. It could enhance longevity, health, and spirituality. According to Maha Narayana Upanishad (~5000 B.C.) it promotes a life expectancy of 100–150 years and it is recommended for "Saints". All foods included in this diet are fresh, juicy, nutritious, and tasty, thus including the consumption of fresh fruits and vegetables, sprouted grains, roots, tubers, nuts, cow milk, curd, and honey. The *sattvic* dietary pattern appears to be similar to a modern but prudent dietary pattern.
- The *Rajasic* diet (over stimulating) is believed to produce jealousy, anger, unfaithfulness, fantasies, and selfishness. It is recommended to leaders and fighters since it may cause excitement, confidence and increase in intelligence. The foods in this diet are bitter, tart, salty, spicy, hot, and dry; they also include white sugar, radishes, and fried foods.
- The *Tamasic* diet (weakens and makes sleepy) is believed to increase pessimism, weakness, laziness, and doubt. The yoga practitioners mention[21,52,53] that this dietary pattern makes one dull, enhances anger and criminal tendency and impedes spiritual progress. The life expectancy is low, and it is bad for health. The foods in this diet include meats from big tamed animals, onions, mushrooms, stale, undercooked-and highly fried foods, high fat fried foods, salt, sugar, spices, chilies pepper, butter and liquor; medicines and stimulants are also included.

Agte and Chiplonkar[21] compiled a database of nutrient contents of 110-food items in two nonconsecutive 24 h-dietary recall of 109 apparently healthy adults. They classified the foods according to their *gunas*; the Sattvic food had the highest micronutrient density, followed by *Rajasic* and *Tamasic*. Although fiber content was quite similar (~14 mg/kcal), the fat content was 18%, 42%, and 72%, respectively. Dietary intake of *Sattvic*, *Rajasic* and *Tamasic* were ~802, ~61 and ~213 g/d. They also included associations among micronutrients food, gunas, and anxiety. *Sattvic* food intake had the highest correlation with food micronutrients (~$r = 0.5$, $P < 0.01$), *Rajasic* only with thiamin intake ($r = 0.47$, $P < 0.01$) and *Tamasic* with zinc ($r = 0.23$, $P < 0.01$), iron ($r = 0.30$, $P < 0.01$) and the presence of anxiety ($r = 0.37$, $P < 0.01$). From this evidence, the authors argued that *Sattvic* food have the better health benefits. The authors included in their study a diet plan that would allow reduction of *Tamasic* and *Rajasic* foods and an increase in those *Sattvic*.

It is noteworthy that *Sattvic* food included a significant amount of functional foods such as soy milk (flavonoids),

tomatoes (lycopene), herbal teas (polyphenols) and red amaranth (bioactive peptides). There is also some evidence that practicing other disciplines in which the mind-body axis is used (e.g. Tai Chi), changes the pattern of food consumption. In this respect, practitioners (mainly from Asian countries) of these disciplines have diets based on a wide variety of vegetables, fruits, vegetables, and spices,[52,53] thereby obtaining a high intake of micronutrients and functional ingredients,[54,55] in addition to a reduced amount of dietary fat.[52,56]

Cross-sectional studies show that yoga practitioners have better dietary patterns than their sedentary counterparts. Palasuwan *et al*.,[56] when evaluating dietary intake and cardiovascular risk factors in pre and postmenopausal Thai women who practice Yoga versus. Tai Chi practitioners or sedentary women, found that yoga practitioners have lower intakes of fats and (BMI, kg/m^2); the enzymatic antioxidant activity were similar among groups. When multidisciplinary interventions in which dietary habits, physical activity, stress management and *HY* are included, significant improvements in overall health is shown as a result of the intervention.[57] Ross *et al*.[16] postulate that home practice of yoga predicts healthy lifestyle changes including an increased intake of fresh fruits and vegetables. Also, preliminary data obtained from a dietary evaluation in Mexican *HY* practitioners indicate important changes toward a healthier and adequate diet [Table 1] and the gradual inclusion of functional ingredients such as fiber foods, lignans and flavonoids [Figure 1].

However, there are still important questions about the relationship between diet and yoga, particularly on how a practice of yoga changes other specific aspects of the diet (e.g., antioxidant intake) or how it modifies other biomarkers of dietary change (e.g., homocysteine). Studies on these issues should not only consider the qualitative and quantitative aspects involved but also the holistic nature of the phenomenon. Nevertheless and despite very few studies involving dietary assessment in yoga practitioners (beginners and/or advanced), it can be safely concluded that the improvement in the spiritual well-being results in a healthier EB in the long-term.[58] In this sense, *Ayurvedic* (*Sanskrit*: *Ayus* [meaning life] and *Veda* [knowledge]) treatments which consists of use herbal preparations, diet, yoga, meditation, and other practices, is gaining recognition in Western societies as a holistic alternative intended to treat many metabolic and neuropsychiatric disorders from a predictive, preventive and personalized medicine standpoint.[59]

Table 1: Daily nutrient adequacy (%) of Mexican yoga practitioners *from Northern Mexico

	Average	Median
Energy	107.5	95.5
Total fiber	132.6	119.8
Soluble fiber	64.1	57.3
Insoluble fiber	131.7	119.4
Protein	137.5	128.2
Total fat	98.9	85.1
Saturated fat	108.5	96.5
Calcium	144.4	86.6
Vitamin C	361.1	304.9
Folates	119.3	109.0
Iron	124.5	115.6
Zinc	119.2	107.5

Source: Author's unpublished data, *52±16 years, 65% female

YOGA AND EATING DISORDERS

The Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition, Text Revision,[60] lists three major types of ED: Anorexia nervosa, bulimia nervosa, and unidentified disorders. Anxiety and depression are common neuropsychiatric conditions in individuals with ED, being seen in ~60% of patients with anorexia and bulimia nervosa.[61] On the other hand, binge eating is a disorder that is characterized by several criteria[60] which include consuming large amounts of food accompanied by feeling of a lack of control. Clinical, community, and population studies have reported that this disorder is associated with being overweight and severe adiposity.[62] The treatment for the different forms of ED is based mainly on cognitive-behavioral and interpersonal therapy with the purpose of inducing positive behavioral changes concerning the people's food intake. However, the lack of progress in treatment development, at least in part, reflects the fact that little is known about the pathophysiologic mechanisms that account for the development and persistence of ED.[63]

Yoga, while seeking for the harmony of the mind and body, benefits people at risk or with established ED. Dittmann and Freedman,[53] when studying body self-perception, attitudes toward food, and the spiritual beliefs of 158 female Yoga practitioners, observed improvements in body satisfaction and self-acceptance along with reduced

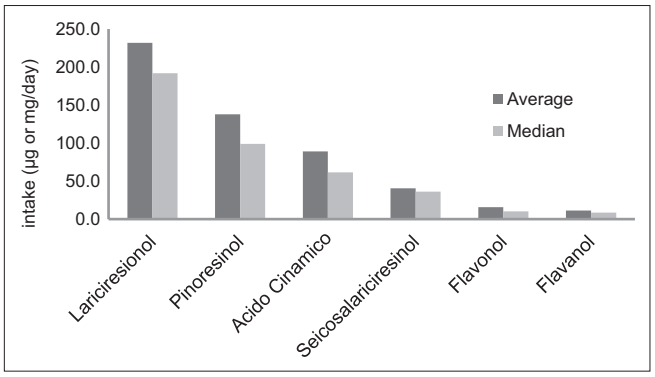

Figure 1: Lignans (µg/d) and flavonoid intake (mg/d) of Mexican yoga practitioners *from Northern Mexico. Source: Author's unpublished data; *52 ± 16 years old, 65% female

disordered eating associated to their Yoga practice. Similarly, intervention programs in which Yoga is included as an alternative to the treatment of ED in persons with chronic obesity have shown that 12 weeks of *HY* practice reduces compulsive eating (binge eating), lengthens meal times and improves food quality.[64] Other interventions, in which problems of anorexia and bulimia nervosa are dealt with Yoga practice, also show similar results. Carei *et al*.,[65] when studying 54 girls (11–21 years) with ED, found that 1 h/2 times/week sessions of Yoga for 8 weeks reduces symptoms of depression, anxiety, and worries about food as compared to girls with ED treated with conventional clinical methods. However, other studies have shown the opposite, especially when Yoga is compared to other psychological strategies. For example, Mitchell *et al*.,[66] when studying ED in school age women through Yoga and cognitive dissonance techniques, found that Yoga fails to change these disorders, but cognitive dissonance reduced anxiety and the inability to express emotions (alexithymia), improving self-perception of the body as well. It is important to note at this point that the success of clinical interventions for patients with ED, depends on many factors, but some of them have to do with age, the type of disorder and the severity of symptoms that often accompany them.[67] In conclusion, these and other studies show that the common practice of *HY* can impact positively on several EDs. However, more studies are needed that compare *HY* versus alternative clinical treatments for ED.

CONCLUSION

Contemporary *HY* (*asanas* + *pranayamas* + *dhyana*), seen holistically, is effective for certain health problems such as hypertension, ED, stress, among others. However, due to their low intensity and low EE, they are not recommended for weight loss or improving cardiovascular conditioning. There are alternative exercises like *Surya Namaskar,* which can be included in its everyday practice, thereby improving health benefits. Also, the practice of Yoga is associated to healthy EBs such a higher consumption of fresh vegetables, dairy products, whole-grains and functional foods (e.g. soy-based products), which could help in ED, but more case–control studies are needed to recommend it as a clinical approach in eating disorders.

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