

VIGOROUS PHYSICAL ACTIVITY OF MEN BY MEANS OF THE INTEGRAL INDICATOR TO THEIR LIFESTYLES

OLES PRYSHVA

Department of Physical Education and Sport, Kherson State University, Kherson, UKRAINE.

Email: ooobc@yahoo.com

How to cite this article: Pryshva, O. (March 2020). Vigorous physical activity of men by means of the integral indicator to their lifestyles. Journal of Physical Education Research, Volume 7, Issue I, 01-08.

Received: January 02, 2020

Accepted: March 28, 2020

ABSTRACT

The physical activity (PA) of a person is an integral part of his life. Modern conditions do not require people to make physical efforts that were the basis of survival in the past and genetically provided, especially for men. Therefore, insufficient daily PA causes serious physiological disorders of the body and provokes age-related diseases. Vigorous physical activity (VPA) is most effective for human health. The desire and the corresponding operational physical condition determined by the energy component of vital activity are necessary before the experiment of the VPA. The most significant physiological factors of vital activity are general PA and nutrition. The purpose of this research was to analyze the effectiveness of the method of natural activation of VPA in men by correcting the daily PA and nutrition in the winter season. Daily PA and nutrition in men on the eve of VPA was investigated. The studied models of PA and nutrition were experimentally investigated. The results of investigation were the significant (<0.05) differences in the integral indicator of steps to grams consumed food and the weight of consume the animal food between the days before the VPA and usual. By using this model, men can increase the VPA's exercises by 56%; VPA's steps by 34%; minutes of classes by 18.86%. Positive changes were noted in the physical condition of men: systolic blood pressure decreased by 5.54%; the index of tension cardiovascular system decreased by 7.19%.

Keywords: Lifestyle, physical activity, nutrition, physical condition.

1. INTRODUCTION

The problem of a sedentary lifestyle of mature age men is quite urgent and widely discussed because of the adverse health consequences. Modern living conditions for men do not allow performing genetically programmed heavy physical work and physically active state during the daylight hours (Dunstan, Howard, & Healy, 2012). The World Health Organization and other studies (Pryshva, 2013) indicate an inadequate PA especially of medium and high intensity in the adulthood. Among many factors of a person's lifestyle, physical activity of high and moderate intensity is the most effective for the normalization of the cardiovascular system and the general physiological state (Carson, Tremblay, & Chaput, 2016). PA of moderate intensity in the form of walking, other household activity by means of the heart rate in the range of 120-140 is realized, largely, in a daily activity. Vigorous physical activity (VPA), with a heart rate above 140, differs from other types of PA with a longer recovery process - up to 48 hours (Speakman, & Selman, 2006). At this period the body consumes by 6-15% more oxygen than under normal conditions (La Forgia, Withers, & Gore, 2006), extending the positive effect on the body. Exercise for endurance of medium and high intensity (more than 55% of maximum) contribute lowering blood pressure (BP)

at rest than low intensity exercise (Cornelissen, & Smart, 2013). At the same time, VPA requires a previous experience and an appropriate physical condition of a person capable of energetically providing significant physical exertion (Pryshva, 2016).

Factors of human physiology provide the accumulation or expenditure of energy reserves of the body within 24 hours. The most important of them are PA and nutrition that are functionally multidirectional. It is not informative to investigate the effect on the human physical condition of each of them individually in a 24-hour format, since all components of the energy balance interact with each other, leveling out the influence of each other (Chaput, Carson, & Gray, 2014). There is a need to search for integral approaches to the assessment of lifestyle components in the daily format (Hall, Heymsfield, & Kemnitz, 2012) and with their help activation of VPA of men.

Ways to intensify the PA of mature age men should be sought in optimizing of their physical condition. Previous studies (Pryshva, 2016a) proved the dependence of VPA of men from the changes in the operative state of cardiovascular system and the general physiological state of the organism at the beginning of the working day. Recent studies (Tremblay, Carson, & Chaput, 2016; Halsey, Huber, & Low, 2012) prove the dependence of the physical condition of mature age men without bad habits from PA, nutrition, sedentary lifestyle and rest. Our research has revealed the most informative factors of vital activity of mature age men of a sedentary lifestyle – the total physical activity and weight of consumed products in a 24-hour format (Pryshva, 2016a).

The theory of energy homeostasis of the organism lies at the heart of physiological factors of vital activity. One part of the factors is aimed at the energy expenditure for adaptation and development, the other for the accumulation of energy and recovery of the body. The physical state of a person is optimized while balancing expenditures and accumulating energy (Blundell, Gibbons, & Caudwell, 2015). An increase energy expenditure in PA can be more effective for the physical condition than limiting its accumulation by food (Hume, Yokum, & Stice, 2016). Energy costs are particularly effective for PA with high intensity (≥ 4 days / week) compared with the moderate intensity (Blundell, 2011; Beaulieu, Hopkins, & Blundell, 2017).

The main way of accumulating energy in the body is nutrition. Consumption of energy-intensive food has a higher priority for the type of nutrition of mature age people in comparison with the influence of PA (Beaulieu, Hopkins, & Blundell, 2017). Excessive nutrition or consumption of energy-intensive products leads to the accumulation of energy reserves, to increased body weight, BP growth and chronic diseases (Vernarelli, Mitchell, & Rolls, 2015). In addition to the energy intensity of products in the accumulation of energy, there is an importance of the speed of their catabolism in the organism. A faster accumulation of energy is promoted by food of plants origin (hydrocarbons), (Baker, Nuccio, & Jeuk, 2014). In addition, the sedentary lifestyle, in comparison with the active one, increases the energy balance by almost half of the daily norm with the same energy diets (Murgatroyd, Goldberg, & Leahy, 1999). At present, the interrelation of consumption of certain groups of products with the intensity of PA has been investigated (Pryshva, & Tsos, 2016). With the increase in the level of PA, the quantity of consumed products also increases (Beaulieu, Hopkins, & Blundell, 2016).

In our previous studies (Pryshva, 2015), the interrelation of the physical condition of men with an integral measure of the number of steps passed per day divided by one gram of food consumed per day was revealed. This relationship turned out to be closer than being separately investigated with PA and nutrition. Therefore, to investigate by means of integral indicator of the physical activity and nutrition of mature age men before of VPA will be relevant daily. Checking the effectiveness of the integral indicator of physical activity and nutrition will make it possible to use it more widely while influencing the physical condition and the intensification of physical activity of men.

2. METHODS AND MATERIALS

2.1 Research Design

The study was based on experimental design of research and it was conducted in the South of Ukraine in the winters of 2016.

2.2 Participants and Procedures

Twenty-four (24) people aged 32-55 years, leading a healthy lifestyle and who have involved in jogging, swimming and fitness were recruited as participants of the study. All the participants were instructed at the Department of Biomedical Disciplines of Kherson State University and observing the necessary procedural standards in the study of their physical condition, nutrition, and use of the bioregistrators.

The experiment consisted two parts of 21 days each. At the first stage, the physical condition of participants i.e. their physical activity and nutrition were examined. The participants of the experiment led a normal life and recorded their physical state in the morning: body weight (g), heart rate, blood pressure. The total weight of consumed products was classified by origin – plants, animal, measured per day to 10g. Physical activity, in the number of the passed steps and heart rate, was recorded 24 hours a day by the bioregistrators Basis B1, Basis Peak.

By the condition at the first stage of the experiment, men did not plan to exercise VPA in advance, but did it when an individual desire arose.

At the second stage, men were asked to adhere the integral indicator of the quantities of steps passed to the quantities of grams consumed food and the energy intensity of consumed products determined at the first stage of the experiment. The energy intensity of the products was controlled by the percentage of the weight of animal products in the relative general educational consumed weight of the products. Men could exercise VPA if there was a corresponding desire.

By weekly reports of the subjects and access to the results of bioregistrators, investigator calculated the body mass index (BMI) (kg/m²); the index of tension cardiovascular system (ITCVS), heart rate while doing VPA; the number of steps passed, divided by the quantities of grams of food consumed per day (step/h), (Pryshva, 2015). ITCVS was calculated in absolute units (a.u.) according to the formula:

$APB = 0.011 \cdot HR + 0.014 \cdot SBP + 0.008 \cdot DBP + 0.014 \cdot Age + 0.009 \cdot BM + 0.009 \cdot BL - 0.273$,
where, heart rate – HR (beats per minute); SBP – systolic blood pressure, (mmHg); DPB diastolic blood pressure, (mmHg); BM – body mass, (kg); BL – body length, (sm); Age – age of the participant, (years) (Baevsky, 1993).

The results of men VPA was presented in a week. General PA, without VPA, presented in a daily format. Percentage was calculated using the formula

$$x = (b-a) : a * 100\%$$

where, *x* was the percentage value; *A* – the previous figure, *b* – the next indicator of a comparable pair of numbers.

2.3 Statistical Analysis of Data

The statistic calculation was carried out by nonparametric statistic methods, since the results did not correspond to the normal distribution. It was determined: 95% interquartile range (IR), median (Me). The comparison of the indices between the days was carried out with the help of the criterion of the significant Wilcoxon ranks with the reliability (*p* =

0.05). The M.S. Excel and Statgraphics16 programs were used for all these statistical calculations.

3. RESULTS

Table 1: Comparison of physical condition, physical activity, nutrition and the integral indicator of men before VPA classes with usual ones

No.	Indicator	Before the VPA (n=129)	Usual (n=481)	Difference (%)	W (p)
		<i>Me</i> (95% IR)	<i>Me</i> (95% IR)		
1.	BMI (kg/m^2)	27.91 (25.01; 30.81)	27.94 (25.83; 30.05)	0.13	24744 >0.05
2.	ITCVS (a.o.)	1.60 (1.52; 1.68)	1.67 (1.58; 1.76)	4.41	38774 >0.05
3.	Integral indicator steps to grams consumed food per day(<i>step/g</i>)	2.2 (1.68; 2.72)	2.68 (2.04; 3.32)	21.75	63452 <0.05
4.	PA general (step/day)	5510.43 (4271.35; 6749.51)	5922.56 (4617.62; 7227.5)	7.46	53506 <0.05
5.	The relative weight of the food consumed (g/kg)	29.73 (26.69; 32.77)	27.81 (24.17; 31.45)	-6.44	43429 <0.05
6.	Proportion of animal food (%)	22.50 (18.28; 26.72)	26.07 (21.06; 31.08)	15.89	58137 <0.05
7.	Proportion of plant foods (%)	69.85 (60.17; 79.53)	65.11 (59.72; 70.5)	-6.84	44509 <0.05

Comparative analysis of the physical state of men (Table 1), reflected in BMI, found redundancy in the weight of the experiment participants. Before the VPA, the BMI was 27.91 kg/m^2 and had no significant differences with the daily indicators of 27.94 kg/m^2 . The complex indicator of the cardiovascular system - ITCVS state before the VPA was in the relative norm - 1.60a.o., and did not have significant differences with the daily - in 1.67a.o. Integral indicator steps to grams consumed food on the day before was 2.2 steps/h, which was significantly lower by 21.75% than on a daily basis - 2.68 steps/hour of consumed food. General PA before was – 5510.43 times per day significantly lower by 7.46% than in day-to-day – 5922.56 steps/day. The relative weight of food consumed by men before the VPA was 29.73 g/kg, significantly more by 6.44% than daily – 27.81 g/kg. The share of animal food of men before the VPA was 22.50%, significantly less by 15.89% than in day-to-day – 26.07%. The share of plant foods the day before was 69.85%, significantly more at 6.84% than in day-to-day – 65.11%. The percentage composition of men's food corresponded the normative indicators of the recommendations of the Ministry of Health of Ukraine 2013.

A result of the second stage of the experiment, where men intentionally adhered to integral indicator as determined by the first stage, the following changes in their physical state, physical activity, and nutrition were noted (Tab. 2). BMI of men in the second stage was 28.08 kg/m^2 – there were no significant differences with the parameters of the usual measurements of the first stage of the experiment. The body weight was 87.97 kg, there were no significant changes. The heart rate at rest was 48.8 beats per minute and did not differ significantly. The systolic blood pressure in rest at the first stage of the experiment was 114.58 mmHg, at the second stage it was by 5.54% less – 108.23 mmHg. Diastolic blood pressure at rest in the first stage was – 64.44 mmHg at the second – 61.77 mm Hg, without significant differences. The composite cardiovascular system of men – the index of tension cardiovascular system at the second stage of the experiment was 1.55a.o., which

was significantly less by 7.19% from the indicator of the first stage. In the second stage, the integral indicator of the steps to grams consumed food was 2.32 step/h, which was 13.43% less than the indicator of the first stage. General PA did not change at the second stage of the experiment; men passed 5835.9 steps/day. The relative weight of consumed food significantly increased by 11.15%, to 30.91g/kg. The daily portion of animal food of men significantly decreased in the second stage of the experiment by 8.82%, to 23.77%. The proportion of plant food significantly increased by 5.22% to 68.51%. VPA at the first stage was 2,897.85 step/week, on the second stage it increased by 34.64%, up to 3901.01 step/week. The number of VPA classes also increased by 56%, from 1.75 times/week, 2.73 times/week in the second stage. The time of VPA's classes also increased by 18.86%, from 20.1 times/week, to 23.89 times/week. The heart rate during VPA's training did not change significantly, at the first stage it was 141.61 beats per minute, at the second - 144.39 beats per minute.

Table 2: Comparison of physical state, physical activity, nutrition and integral indicator of men in the stages of the experiment

No	Indicator	The first stage of the experiment (n=481)	The second stage of the experiment (n=470)	Difference (%)	W (p)
		<i>Me</i> (95% IR)	<i>Me</i> (95% IR)		
1.	BMI (kg/m ²)	27.94 (25.83; 30.05)	28.08 (26.03; 30.13)	-0.57	68512 >0.05
2.	Body mass (kg)	87.57 (82.76; 92.38)	87.97 (82.64; 93.3)	0.46	61824 >0.05
3.	HR (beats per minute)	50.36 (46.68; 54.04)	48.8 (44.14; 53.46)	-3.10	63795 >0.05
4.	SBP (mmHg)	114.58 (106.72; 122.44)	108.23 (99.16; 117.3)	-5.54	75143 <0.05
5.	DBP (mmHg)	64.44 (60.18; 68.7)	61.77 (56.81; 66.73)	-4.14	67842 >0.05
6.	ITCVS (a.o.)	1.67 (1.58; 1.76)	1.55 (1.46; 1.64)	-7.19	80175 <0.05
7.	Integral indicator steps to grams consumed food per day(step/g)	2.68 (2.04; 3.32)	2.32 (2.14; 2.5)	-13.43	79458 <0.05
8.	PA general (step/day)	5922.56 (4617.62; 7227.5)	5835.9 (4563.28; 7108.52)	1.46	68457 >0.05
9.	The relative weight of the food consumed (g/kg)	27.81 (24.17; 31.45)	30.91 (25.34; 36.48)	11.15	78462 <0.05
10.	Proportion of animal food (%)	26.07 (21.06; 31.08)	23.77 (20.34; 27.2)	-8.82	72083 <0.05
11.	Proportion of plant foods (%)	65.11 (59.72; 70.5)	68.51 (60.75; 76.25)	5.22	70841 <0.05
12.	VPA (step/week)	2897.85 (2638.41; 4505.89)	3901.01 (3128.56; 5380.68)	34.64	84247 <0.05
13.	Number VPA classes (times/week)	1.75 (1.03; 3.05)	2.73 (1.84; 3.62)	56.0	89192 <0.05
14.	VPA duration (min/week)	20.1 (16.28; 24.94)	23.89 (17.56; 30.22)	18.86	77175 <0.05
15.	HR VPA (beats per minute)	141.61 (130.74; 152.48)	144.39 (131.51; 155.27)	1.96	64754 >0.05

4. DISCUSSION

According to the results of the first stage of physical activity and nutrition studies by an integrated method, the difference between the integral indicator steps to grams consumed

food before the VPA was first applied and revealed in comparison with everyday measurements. Comparative analysis of PA and nutrition confirmed their energy diversity in the energy balance of the organism (Hall, Heymsfield, & Kemnitz, 2012). PA was smaller, and the relative weight of the food consumed was bigger. The percentage of integral indicator steps to grams consumed food difference before the VPA daily proved to be greater than the separately taken PA and nutrition indicators, confirming the informative value of the integral indicator indicator (Pryshva, 2015). The use of integral indicator allowed to control the accumulation and energy consumption of the body in terms of the number of steps passed, and the weight of the consumed products.

The increase in the relative weight of food consumed by men before the VPA confirms the previous study (Pryshva, 2016a). The proportion of plant food (65%), as the main resource for the accumulation of energy reserves, was in line with the recommendations recommended by the Ministry of Health of Ukraine 2013, Dietary Guidelines for Americans 2010, 2015, and was reasonably longer the day before the VPA. The proportion of animal food before the VPA was significantly less than on usual days. This fact requires additional investigation, since the accumulation of excess energy reserves occurs just before the VPA. A similar result was obtained by our previous studies (Pryshva, 2016a), where the relative weight of products of animal origin in winter was also by 8.7% less. Perhaps during the usual days of the winter, excessive consumption of energy-intensive animal food, the body of men spent more energy in short-term metabolic processes than it got (Baker, Nuccio, & Jeuk, 2014).

The analysis of the physical condition of men confirmed the absence of changes in the comparative measurements of BMI and the index of tension cardiovascular system the day before with daily occurrence, which was consistent with our previous research (Pryshva, 2016b), where body weight and the index of tension cardiovascular system under similar study conditions also did not have statistical validity.

Based on the results of the second stage of the experiment, the effect of the integral indicator steps to grams consumed food on the physical state of men was first investigated. Because of modeling the daily integral indicator in 2.2 steps per kilogram of consumed food with an animal food proportion of 22.5%, an interval of 2 days, significant changes in the physical condition of men were recorded. Which correlate with the data (Cornelissen, & Smart, 2013), about the decrease of blood pressure, and the normalization of cardiovascular system with increasing VPA (Carson, Ridgers, & Howard, 2013). A significant decrease in integral indicator steps to grams consumed food is a testimony to 94% of the compliance with model recommendations. There were no significant changes in heart rate and diastolic blood pressure.

For the first time, the indirect effect of the integral indicator of steps to grams consumed food on the intensification of PA of mature age men was revealed. The result of changes in their physical condition is the reliable increase in the number of steps, the number of classes, the duration of VPA's classes during the week, according to the data of previous studies (Pryshva, 2016a), about the dependence of the VPA on men and their way of life. The intensification of PA was due to the quantities of steps passed to the quantities of grams of food taken for the first time, modeled and used among men of mature age. The results indicate that significant changes in the components of the integral indicator were only in the consumption of food. The relative weight of food increased, and the total PA did not change. This situation is confirmed and explained by the previous study (Beaulieu, Hopkins, & Blundell, 2017), about the leading role of nutrition in comparison with the physiological or behavioral influence of PA.

The percentage balance of the products consumed by men has significantly changed. The proportion of animal food decreased to 8.82%. The proportion of plant foods increased due to the VPA, confirming the studies (Baker, Nuccio, & Jeuk, 2014; Beaulieu,

Hopkins, & Blundell, 2016) about the rapid accumulation of energy because of hydrocarbon consumption with increasing of PA.

5. CONCLUSION

The study of the integral indicator steps to grams consumed food of mature age men before the VPA was by 21.75% lower than usual. The weight of animal food was by 15.89% less. In the future, during this model of integral indicator steps to grams consumed food for men, in the weekly format, the number of VPA exercises increased: VPA`s exercises by 56%; VPA`s steps by 34%; minutes of classes by 18.86%. Positive changes were noted in the physical condition of men: systolic blood pressure decreased by 5.54%; the index of tension cardiovascular system decreased by 7.19%. The accumulation of energy reserves before the VPA in the winter period was determined by an increase in the relative weight of consumption of vegetable products by men by 5.22% and a decrease in the animal by 8.82%.

6. REFERENCES

- Baevsky, R.M. (1993). Preclinical diagnosis in the evaluation of health status. *Valeology: diagnostics, tools and practices for health. Science & Research - Saint Petersburg Polytechnic University*, 230.
- Baker, L., Nuccio, R., Jeuk, & Rup, A. (2014). Acute effects of dietary constituents on motor skill and cognitive performance in athletes. *Nutrition Review*, 72, 790-802.
- Beaulieu, K., Hopkins, M., & Blundell, J. (2016). Does habitual physical activity increase the sensitivity of the appetite control system? A systematic review. *Sports Medicine*, 46, 1897-1919.
- Beaulieu, K., Hopkins, M., & Blundell, J. (2017). Impact of physical activity level and dietary fat content on passive overconsumption of energy in non-obese adults. *International Journal of Behavioral Nutrition and Physical Activity*, 14(1), 14.
- Blundell, J. (2011). Physical activity and appetite control: Can we close the energy gap? *Nutrition Bulletin*, 36, 356-366.
- Blundell, J., Gibbons, C., & Caudwell P. (2015). Appetite control and energy balance: impact of exercise. *Obesity Review*, 16, 67-76.
- Carson, V., Ridgers, N., Howard, B. Winkler, E.A., Healy, G.N., Owen, N., Dunstan, D.W., & Salmon, J. (2013). Light-intensity physical activity and cardio metabolic biomarkers in U.S. adolescents. *PLoS One*, 8(8), e71417.
- Carson, V., Tremblay, M., & Chaput, J. (2016). Associations between sleep duration, sedentary time, physical activity and health indicators among Canadian children and youth using compositional analyses. *Applied Physiology, Nutrition, and Metabolism*, 41(10), 1139-0026.
- Chaput, J., Carson, V., & Gray, C. (2014). Importance of all movement behaviors in a 24-hour period for overall health. *International Journal of Environmental Research and Public Health*, 11, 12575-12581.
- Cornelissen, V., & Smart, N. (2013). Exercise training for blood pressure: a systematic review and meta-analysis. *Journal of the American Heart Association*, 2(1), e004473.
- Dunstan, D., Howard, B., & Healy, G. (2012). Too much sitting - A health hazard. *Diabetes Research and Clinical Practice*, 97, 368-376.
- Hall, K., Heymsfield, S., & Kemnitz, J. (2012). Energy balance and its components: implications for body weight regulation. *American Journal of Clinical Nutrition*, 95(4), 989-994.
- Halsey, L., Huber, J., & Low, T. (2012). Does consuming breakfast influence activity levels? An experiment into the effect of breakfast consumption on eating habits and energy expenditure. *Public Health and Nutrition*, 15(2), 238-245.
- Hume, D., Yokum, S., & Stice, E. (2016). Low energy intake plus low energy expenditure (low energy flux), not energy surfeit, predicts future body fat gain. *American Journal of Clinical Nutrition*, 103, 1389-1396.
- La Forgia, J., Withers, R., & Gore, C. (2006). Effects of exercise intensity and duration on the excess post-exercise oxygen consumption. *Journal of Sports Sciences*, 24, 1247-1264.
- Murgatroyd, P., Goldberg, G., & Leahy, F. (1999). Effects of inactivity and diet composition on human energy balance. *International Journal of Obesity Related and Metabolic Disorder*, 23, 1269-1275.
- Pryshva, O. (2013). Features of physical activity males mature. *Molodizhnyi naukovyi visnyk Shkhidnoievropeiskoho natsionalnoho universytetu imeni Lesi Ukrainky. Fizychnye vykhovannia I sport*, 10, 59-63. (in Ukraine)

- Pryshva, O. (2016a). Influence of lifestyle mature age men for their vigorous physical activity in summer period. *Fizychnye vyxovannya, sport i kultura zdorov'ya u suchasnomu suspilstvi*, 4, 73-80. (in Ukraine)
- Pryshva, O. (2016b). The impact of the cardiovascular system of a mature-aged men on their physical activity during the autumn period. *Fizychnye vyxovannya, sport i kultura zdorov'ya u suchasnomu suspilstvi*, 2(34), 38-45. (in Ukraine)
- Pryshva, O. (2016c). Peculiar features of men physical condition in planning highly intensive physical loads in winter period. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, 20(2), 46-51.
- Pryshva, O. (2015). Integral way evaluating the impact of physical activity and nutrition on physical condition of men. *Fizychnye vyxovannya, sport i kultura zdorov'ya u suchasnomu suspilstvi*, 31, 156-159. (in Ukraine)
- Pryshva, O., & Tsos, A. (2016). Interconnection of a physical activity of mature males with their diet. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 7(6).
- Speakman, J., & Selman, C. (2006). Physical activity and resting metabolic rate. *Proceedings of the Nutrition Society* 2003, 62, 621-634.
- Tremblay, M., Carson, V., & Chaput, J. (2016). Canadian 24-hour movement guidelines for children and youth: an integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, 41, 311-327.
- Vernarelli, J., Mitchell, D., & Rolls, B. (2015). Dietary energy density is associated with obesity and other biomarkers of chronic disease in US adults. *European Journal of Nutrition*, 54, 59-65.