Online ISSN: 3107-8079

KSV Journal of Pharmacy and Health Sciences

(Managed by K. B. Institute of Pharmaceutical Education and Research, Gandhinagar-382023, Gujarat, India)

Open Access

Research article

EFFECT OF MAGNESIUM AND HYDROXYPROPYL METHYLCELLULOSE CO-SUPPLEMENTATION WITH HIGH FAT DIET IN WEIGHT MANAGEMENT IN OBESITY IN RATS

Mansuri Javid*, Patel Khusi, Shah Palak, Makwana Payal

Department of Pharmacology, K.B. Institute of Pharmaceutical Education and Research, A constituent college of Kadi Sarva Vishwavidyalaya, Sector-23, Gandhinagar, Gujarat, India

Abstract

Objective: The present study was done to evaluate the effect of Magnesium and Hydroxypropyl Methyl Cellulose (HPMC) co-supplementation along with a high-fat diet (HFD) on metabolic parameters associated with obesity.

Materials and Methods: Male Albino Wistar rats were divided into five groups each containing 6 animals. All the animals except Normal control group I were fed a high-fat diet for 84 days. All the treatment groups received treatment from day 1 itself. Group III was given Magnesium gluconate (containing 58.33 mg elemental magnesium/kg, p.o) along with HFD for 84 days. Group IV was fed with 8% HPMC mixed with HFD for 84 days. Group V was given Magnesium gluconate (containing 58.33 mg elemental magnesium/kg, p.o) + 8% HPMC (mixed with HFD) for 84 days. During the experiment, body weight and food intake were measured weekly and BMI was measured on day 0 and 84. Serum total cholesterol, triglyceride, LDL, HDL, and magnesium levels were measured at days 0, 42, and 84. Fecal stool analysis was done on days 83 and 84, while fat mass was measured at the end of the study.

Results: Co-supplementation of Magnesium and HPMC with HFD significantly reduced body weight, BMI, triglyceride, total cholesterol, LDL, and fat mass, with a significant decrease in food intake. Moreover, a significant increase in the fecal excretion of total bile acids and fatty acids was observed.

Conclusion: The above results suggest that co-supplementation of Magnesium and HPMC not only reduces body weight but also normalizes the metabolic abnormalities associated with obesity and possesses potential fat-reducing and lipid-lowering effects.

Keywords: HFD, obesity, magnesium, HPMC

Article Info: Received on 29/04/2026, Review Completed on 06/05/2026, Accepted on 30/05/2026

Cite this article as:

Mansuri J, Patel K, Shah P, Makwana P. Effect of magnesium and hydroxypropyl methylcellulose co-supplementation with high fat diet in weight management in obesity in rats. KSV Journal of Pharmacy and Health Sciences 2026;3(1):1-6

Available from:

Volume 3, Issue 1 [January 2026 to June 2026] | KSV Journal of Pharmacy and Health Sciences

*Corresponding Author

1. Introduction

Obesity is a complex clinical disorder marked by the accumulation of unneeded, unexpected fat brought on by increased consumption of foods high in energy and sedentary behavior. (1) Overweight and obesity are major lifestyle-related conditions that contribute to the development of several comorbidities, including cardiovascular diseases (CVDs), chronic obstructive pulmonary disease (COPD), cancer, type II diabetes, hypertension, and depression. (2) Numerous efforts have been undertaken to manage the metabolic imbalance associated with obesity, leading to the development of drugs such as fibrates, sibutramine, and orlistat; however, their use is often limited by significant adverse effects. (3) Non-pharmacological tactics have also been employed to treat or prevent metabolic syndrome in addition to pharmaceutical methods that target obesity. The benefits of fiber-rich diets or bioactive dietary ingredients for preventing disease are gaining popularity. (4) The complicated homeostatic system that controls body weight primarily regulates appetite, satiety, and the amount of energy used and stored in adipose tissue. (5) Since the balance between energy intake and expenditure is the main factor in obesity, lowering energy intake and raising energy expenditure are effective approaches to manage obesity. Particularly, dietary patterns are correlated with energy intake. Thus despite the fact that short chain fatty acids (SCFAs) made from non-digestible fatty acids (NDCs) by gut microbiota are used as an energy source, non-digestible components such as HPMC can hinder the absorption of key energy-yielding nutrients, including glucose and lipids, by limiting the interaction between digestive enzymes and their substrates in the intestine. Moreover, these effects can delay gastric emptying, thereby prolonging satiety. Through the activation of satiety hormones like Peptide tyrosine tyrosine (PYY) and Glucagon like peptide 1 (GLP-1) as well as energy-balancing hormones like leptin, SCFAs can also promote satiety. The consumption of NDCs can lower subsequent energy intake. (6) One of the main effects of oxidative stress is lipid peroxidation, which is also promoted by HFD, particularly in the brain where there are lots of polyunsaturated and highly peroxidable fatty acids. Additionally, increased lipid peroxidation along with reduced antioxidant enzyme activity has been reported. Magnesium (Mg) is an essential element required for maintaining normal metabolic functions and ionic balance. It acts as a cofactor in numerous enzyme-catalyzed reactions and plays a vital role in physiological processes such as glycolysis, oxidative phosphorylation, cellular respiration, protein synthesis, and insulin metabolism. (7,8) Thus, magnesium is supplemented in the form of magnesium gluconate to ameliorate the therapeutic effect. (9)

Therefore, the present investigation was undertaken to study the potential use of the combined effect of magnesium and HPMC on improving metabolic parameters of obesity.

2. Materials and methods

Materials

Magnesium gluconate was acquired from Sisco Chem Laboratory Chemicals and Reagents, Maharashtra, India. HPMC was purchased from BRM Chemicals, New Delhi, India. All other chemicals used were of analytical grade.

Animals

Adult male Wistar rats (250–350 g) were employed for this study. They were maintained in clean polypropylene cages, with six animals per cage, under standardized environmental conditions: temperature 22 ± 2°C, relative humidity 55 ± 5%, and a 12-hour light–dark cycle. Before initiating dietary interventions, all animals had free access to a standard commercial pellet diet and water. The study protocol received approval from the Institutional Animal Ethics Committee (IAEC) of K.B. Institute of Pharmaceutical Education and Research, Gandhinagar, Gujarat, India (Protocol No.: KBIPER/2022/652).

Experimental Protocol

Total 30 male Wistar rats were divided into five groups of six animals each.

Group I – Normal control (NC)
Group II- Disease control (DC), HFD- treated
Group III- HFD + MG (Magnesium gluconate)
Group IV- HFD + HPMC (Hydroxypropyl Methylcellulose)
Group V - HFD + MG + HPMC

Group I received a standard pellet diet, whereas Groups II, III, IV, and V were maintained on a high-fat diet (HFD) for the entire 84-day study period. Group III was treated with 58.33 elemental Magnesium mg/kg, p.o, o.i.d (10) for 84 days, group IV was treated with 8% HPMC mixed with HFD (11), and group V was treated with 58.33 mg elemental Magnesium/kg, p.o, o.i.d, and 8% HPMC. The composition of HFD (1 kg) includes powdered normal pellet (300 g), vanaspati ghee (275 g), casein (220 g), egg yolk powder (10 g), vitamin and mineral mix (60 g), dl methionine (3 g), sucrose (150 g) and sodium chloride (2 g). (12) The physical parameters like body weight and food intake were measured weekly, and BMI was measured on day

0 and 84, and biochemical parameters like serum lipid levels and magnesium level were measured on day 0, 42 and 84. Fecal lipid analysis was done on the last two consecutive days of the study. The rats were sacrificed and the fat mass was collected and weighed at the end of the study.

Collection of Blood Samples

Blood samples were obtained on days 0, 42, and 84 from animals fasted overnight, using retro-orbital puncture performed under inhalation anesthesia. The samples were left undisturbed at room temperature for 30 minutes to allow clot formation, after which the serum was separated by centrifugation at 4,000–5,000 rpm for 15 minutes. The collected serum was then analyzed for triglycerides (GPO-PAP), cholesterol (CHOD-PAP), HDL (PEG-CHOD-PAP), and magnesium using commercially available assay kits supplied by Span Diagnostics Ltd., Surat, India.

Fecal lipid Analysis

50 mg frozen stool was taken in 200µl 75% ethanol and then stirred for 2 min following 5 min sonification on ice. 500µl methyl tert butyl ether (MTBE) was added and shaken for 1 hour at room temperature. Later on, 125µl distilled water was added following 2 min stirring and incubation for 10 min at room temperature. At last, the solution was centrifuged at 4°C (15 min), and the supernatant was separated and completely dried in speed Vac. The dried extract was resolved using 50µl of 100% isopropanol, and the mixture was vortexed for 3 min at room temperature.(13) The resolved samples of all the groups were analysed in a UV spectrophotometer at a wavelength of 320nm for fatty acids and 250nm for bile acids and the concentration was calculated.

Fat-pad Analysis

At the end of the study, animals were sacrificed using a CO_2 chamber. The epididymal white adipose tissue was collected and weighed immediately.

Statistical Analysis

The results were presented as mean ± standard error of means (SEM). Quantitative parameters were analyzed using two way anova way ANOVA multiple comparison tests followed by the post hoc Tuckey test. While food intake was analyzed using two-way ANOVA multiple comparison test followed by a post hoc Bonferroni test. A p-value of less than 0.05 was considered statistically significant.

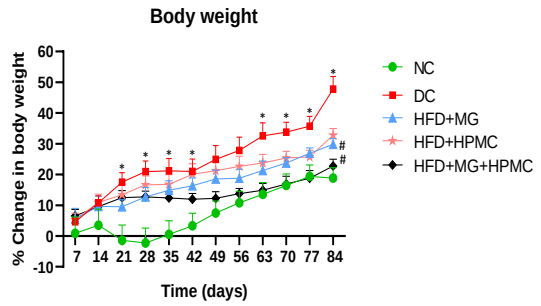
3. Results

Effect of Treatment on Physical Parameters

a. Effect of treatment on body weight

Body weight was measured weekly. The mean % body weight of group II was seen significantly increased at most of the time points during the study. At the end of the study, it showed a significant increase in body weight by 47-52% compared to the control group. While after 84 days, groups III, IV, and V showed a significant decrease in % body weight by 29-31%, 32-35%, and 22- 25% respectively compared to the DC group ($p<0.05$). (**Figure 1)**

Figure 1: Effect of treatment on body weight

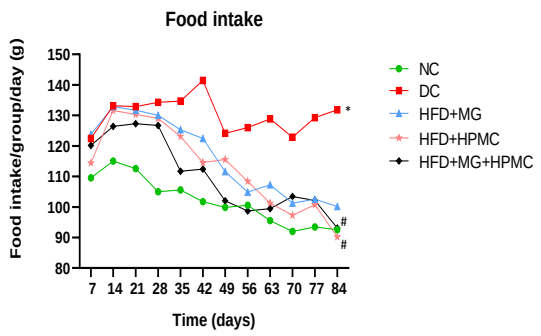


Each bar shows mean± SEM (n = 6). *p<0.05 vs. NC; #p<0.05 vs. DC, analysed using two-way ANOVA followed by Tukey's post hoc test.

b. Effect of treatment on food intake

At the end of the study, as expected group II showed a significant increase in food intake compared to the normal control. Groups IV and V treated animal showed significant decrease in food intake compared to the DC group ($p<0.05$). (**Figure 2)**

Figure 2: Effect of treatment on food intake

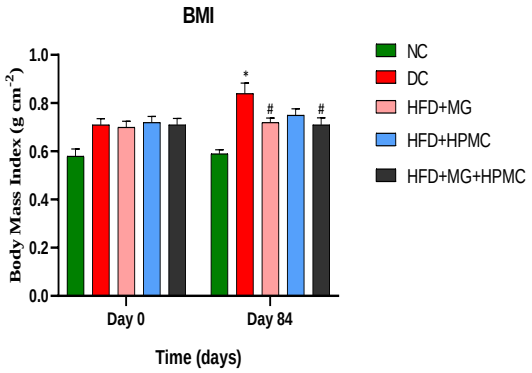


Each bar shows mean ± SEM (n = 6). *p<0.05 vs. NC; #p<0.05 vs. DC, analysed using two-way ANOVA followed by Bonferroni test.

c. Effect of treatment on BMI

BMI was measured on day 0 and day 84. Throughout the study, treatment was effective and thus showed a significant decrease in BMI in groups III, IV, and V compared to the DC group ($p<0.05$) on day 84. **(Figure 3)**

Figure 3: Effect of treatment on BMI



Each bar shows mean ± SEM (n = 6). *p<0.05 vs. NC; #p<0.05 vs. DC, analysed using two-way ANOVA followed by Tukey's post hoc test.

Effect of Treatment on Biochemical Parameters

a. Effect of treatment on serum lipid profile

At the end of the study, serum cholesterol level was significantly decreased in group III, IV, and V while a significant reduction in serum triglyceride and LDL levels was seen only in group IV and V compared to DC group ($p<0.05$), while no significant increase in HDL level was seen in any of the groups. **(Table 1)**

b. Effect of treatment on serum magnesium

Estimation of serum magnesium levels showed no significant decrease in magnesium levels in the DC group which contradicts the already reported study. Although, a significant increase in magnesium level was seen in Mg and HPMC (Group V) treated group compared to the DC group ($p<0.05$). **(Table 1)**

Effect of Treatment on Physical Parameters

a. Effect of treatment on body weight

Body weight was measured weekly. The mean % body weight of group II was seen significantly increased at most of the time points during the study. At the end of the study, it showed a significant increase in body weight by 47-52% compared to the control group. While after 84 days, groups III, IV, and V showed a significant decrease in % body weight by 29-31%, 32-35%, and 22- 25% respectively compared to the DC group ($p<0.05$). (**Figure 1)**

Table 1: Effect of treatment on the biochemical parameters

Biochemical Parameters	Period	NC	DC	HFD + MG	HFD + HPMC	HFD+ MG+ HPMC
Serum TG	**Day 0**	94.90±16.00	100.48±11.03	104.13±27.59	92.98±21.37	101.63±9.05
	Day 42	96.73±9.64	125.74±10.2	110.66±15.1	103.36±9.57	105.28±9.92
	Day 84	93.56±10.17	152.83±8.64*	114.79±5.91	95.67±9.34$^{\#}$	110.08±11.5$^{\#}$
Serum TC	**Day 0**	95.97±5.24	93.76±8.85	95.74±11.4	92.87±10.27	102.41±3.24
	Day 42	93.44±5.42	114.59±9.70	94.82±12.08	94.71±11.54	99.77±3.83
	Day 84	95.28±2.77	134.36±9.32 *	108.50±8.52$^{\#}$	99.54±5.057$^{\#}$	98.5±3.76$^{\#}$
Serum HDL	**Day 0**	45.51±1.08	47.80±0.52	46.64±0.51	45.91±4.11	44.02±1.18
	Day 42	48.40±2.93	42.72±1.35	45.81±2.39	50.61±2.12	47.40±2.02
	Day 84	50.70±2.89	48.26±3.09	50.74±4.15	52.47±2.60	52.27±3.72
Serum LDL	**Day 0**	31.47±8.06	25.88±8.25	28.27±10.71	28.35±10.08	38.06±0.81
	Day 42	25.69±8.00	46.72±8.86	33.43±7.89	23.42±11.49	31.31±1.93
	Day 84	25.86±3.56	55.53±8.16*	34.80±10.12	27.92±5.40$^{\#}$	24.21±2.50$^{\#}$
Serum Magnesium	**Day 0**	1.99±0.04	2.08±0.02	2.06±0.05	1.98±0.08	2.01±0.07
	Day 42	1.96±0.03	2.01±0.04	2.10±0.01	2.02±0.01	2.17±0.05
	Day 84	2.04±0.08	1.84±0.05	2.02±0.03	1.93±0.02	2.10±0.07$^{\#}$

Results are presented as mean ± SEM (n = 6). *p<0.05 vs. NC; #p<0.05 vs. DC, analysed using two-way ANOVA followed by Tukey's post hoc test.

Effect of Treatment on fecal lipid excretion

The results observed in this study showed the increased excretion of bile acid and fatty acid in group IV and group V as compared to DC group. **(Table 2)**

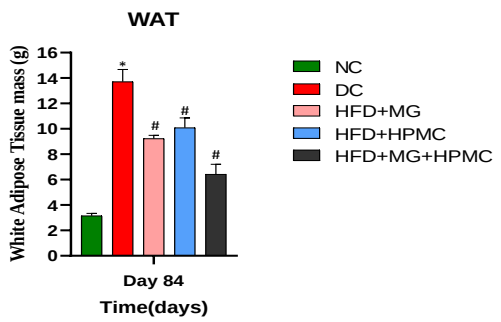
Table 2: Concentration of fatty acid and bile acid in faeces.

Group	Bile acid concentration (mg/ml)	Fatty acid concentration (mg/ml)
NC	0.52	2.1
DC	0.54	2.2
HFD + MG	0.59	2.9
HFD + HPMC	0.79	4.0
HFD+ MG+ HPMC	0.70	3.4

Fat Pad Analysis

There was an accumulation of visceral fat observed in group II as compared to the normal control group measured on day 84. The epididymal (visceral WAT) fat mass accumulation was significantly reduced in all the treatment groups compared to the DC group **(Figure 4)**. This reflects the protective role of magnesium gluconate and HPMC in the increased fat mass condition.

Figure 4: Effect of treatment on WAT mass



Each bar shows mean ± SEM (n = 6). *p<0.05 vs. NC; #p<0.05 vs. DC, analysed using two-way ANOVA followed by Tukey's post hoc test.

4. Discussion

The current investigation was conducted from a therapeutic perspective, focusing on substances that inhibit the absorption of fat and products of fat digestion rather than obstructing enzyme activity. These substances are the most promising medicines since they can mitigate the negative side effects of already existing medications. [1] One of the key elements causing obesity is HFD. According to studies, diets that contain up to 30-85% of their calories from fat might cause obesity and encourage insulin resistance. (14) Thus, a high-fat diet (HFD) model was used to induce obesity similar to humans.

Rats fed a long-term HFD showed increased body weight and plasma co-morbidity characteristics as a result of using a diet high in energy in the form of saturated fats and also the ratio of calorie intake to energy consumption concludes bodyweight. The increase in body weight states the susceptibility of obesity toward food intake. (15) In the present study, the treatment with magnesium and HPMC showed decreased body weight in association with reduced food intake compared to the HFD control group. This result supports the hypothesis of the present study to evaluate the effect of co-administration of Mg and HPMC in the management of obesity.

Adipose tissue plays a crucial role in energy homeostasis and energy storage. It is generally known that insulin can eventually trigger the release of leptin during food metabolism, with particular emphasis on how glucose is used by adipocytes. The fundamental evident fact of obesity is the accumulation of extra fat in adipocytes. (16) In the present study, combination of MG and HPMC with HFD showed significant decrease in adipose tissue accumulation compared to single treated groups.

Obesity caused by HFD is associated with dyslipidemia, which is marked by elevated TG, LDL, and TC levels and decreased plasma HDL levels. (17) In the present study, HFD with HPMC and HFD with MG and HPMC treated groups showed promising lowered TG, and TC levels while the HDL levels were unaffected. Both groups also showed a significant decrease in LDL levels.

Regarding the role of magnesium shortage in the emergence of metabolic syndrome and obesity, several observations have been made and documented. Mg shortage influences the development of various metabolic syndrome markers like hyperlipidemia, elevated blood pressure, endothelial dysfunction, and a higher risk of thrombosis. On the other hand, Mg supplementation has been shown to have antihypertensive effects; it also reduces the risk of insulin resistance and hyperlipidemia associated with metabolic syndrome. (18) In the present study, decreased magnesium levels were observed in HFD-treated groups as compared to the normal-treated group but not significantly which might be due to some homeostatic mechanism of the body. HFD with magnesium and HPMC treated group showed

significant increase in serum magnesium level as compared to disease control group.

A persistently positive energy balance leads to obesity. As a result of this etiological theory, weight gain cannot happen unless calorie ingestion exceeds calorie combustion. The gastrointestinal tract does not, however, absorb every vitamin that is consumed. A portion of the food we eat is eventually eliminated in our feces. Because the equilibrium of the energy balance is disrupted with obesity, fat absorption is more susceptible. (19) In the present study, HPMC was shown to decrease food intake by lengthening intestinal transit time and increasing stomach bulkiness. The outcomes of the HPMC and MG+HPMC treated groups support HPMC's role in boosting bile acid and fatty acid excretion in the feces.

Finally, the findings of the study demonstrated that the co-supplementation of magnesium and HPMC with HFD is one of the successful modalities in body weight management in obese rats.

5. References

1. Lin X, Li H. Obesity: epidemiology, pathophysiology, and therapeutics. Frontiers in Endocrinology. 2021;12:706978.
2. Chatterjee A, Gerdes MW, Martinez SG. Identification of risk factors associated with obesity and overweight- a machine learning overview. Sensors. 2020;20(9):2734.
3. Kang JG, Park CY. Anti-obesity drugs: a review about their effects and safety. Diabetes & Metabolism Journal. 2012;36(1):13-25.
4. Hung SC, Bartley G, Young SA, Albers DR, Dielman DR, Anderson WH, et al. Dietary fiber improves lipid homeostasis and modulates adipocytokines in hamsters. Journal of diabetes. 2009(3):194-206.
5. Gjermeni E, Kirstein AS, Kolbig F, Kirchhof M, Bundalian L, Katzmann JL, et al. Obesity–an update on the basic pathophysiology and review of recent therapeutic advances. Biomolecules. 2021;11(10):1426.
6. Chanmuang S, Nguyen QA, Kim HJ. Current Research on the Effects of Non-Digestible Carbohydrates on Metabolic Disease. Applied Sciences. 2022;12(8):3768.
7. Orhan C, Er B, Deeh PB, Bilgic AA, Ojalvo SP, Komorowski JR, et al. Different sources of dietary magnesium supplementation reduces oxidative stress by regulation Nrf2 and NF-κB signaling pathways in high-fat diet rats. Biological Trace Element Research. 2021;199(11):4162-70.
8. Sahin K, Orhan C, Kucuk O, Tuzcu M, Sahin N, Ozercan IH, et al. Effects of magnesium picolinate, zinc picolinate, and selenomethionine co-supplementation on reproductive hormones, and glucose and lipid metabolism-related protein expressions in male rats fed a high-fat diet. Food Chemistry: Molecular Sciences. 2022;4:100081.
9. Bertinato J, Plouffe LJ, Lavergne C, Ly C. Bioavailability of magnesium from inorganic and organic compounds is similar in rats fed a high phytic acid diet. Magnesium Research. 2014;27(4):175-85.
10. Zhang Q, Qian ZY, Zhou PH, Zhou XL, Zhang DL, He N, et al. Effects of oral selenium and magnesium co-supplementation on lipid metabolism, antioxidative status, histopathological lesions, and related gene expression in rats fed a high-fat diet. Lipids in Health and Disease. 2018;17(1):1-12.
11. Hung SC, Anderson WH, Albers DR, Langhorst ML, Young SA. Effect of hydroxypropyl methylcellulose on obesity and glucose metabolism in a diet-induced obesity mouse model. Journal of Diabetes. 2011;3(2):158-67.
12. Srinivasan K, Viswanad B, Lydia A, Kaul CL, Ramarao P. Combination of high-fat diet-fed and low-dose streptozotocin-treated rat: A model for type 2 diabetes and pharmacological screening. Pharmacological Research. 2005;52:313-2013.
13. Erben V, Poschet G, Schrotz-King P, Brenner H. Evaluation of different stool extraction methods for metabolomics measurements in human faecal samples. BMJ Nutrition, Prevention & Health. 2021;4(2):374-84.
14. Pinheiro-Castro N, Silva LB, Novaes GM, Ong TP. Hypercaloric diet-induced obesity and obesity-related metabolic disorders in experimental models. Reviews on Biomarker Studies of Metabolic and Metabolism-Related Disorders. 2019:149-61.
15. Naidu PB, Uddandrao VS, Naik RR, Suresh P, Meriga B, Begum MS, et al. Ameliorative potential of gingerol: Promising modulation of inflammatory factors and lipid marker enzymes expressions in HFD induced obesity in rats. Molecular and Cellular Endocrinology. 2016;419:139-47.
16. Van Baak MA, Mariman EC. Mechanisms of weight regain after weight loss—the role of adipose tissue. Nature Reviews Endocrinology. 2019;15(5):274-87.
17. Klop B, Elte JW, Castro Cabezas M. Dyslipidemia in obesity: mechanisms and potential targets. Nutrients. 2013;5(4):1218-40.
18. Devaux S, Adrian M, Laurant P, Berthelot A, Quignard-Boulangé A. Dietary magnesium intake alters age-related changes in rat adipose tissue cellularity. Magnesium Research. 2016;29(4):175-83.
19. Lund J, Gerhart-Hines Z, Clemmensen C. Role of energy excretion in human body weight regulation. Trends in Endocrinology & Metabolism. 2020;31(10):705-8.