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Nutritional and Organoleptic Evaluation of Fiber-rich Millet-based Healthy Soup Prepared from *Eleusine coracana* and *Emblica officinalis*

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ABSTRACT

Background: Dried soup powder is one of the easiest-to-cook meals accessible in our nation and it plays an essential role in meeting current and future social consumer needs. The study's main objective is to develop high-dietary fiber, high-protein and low-calorie millet soup by standardizing the ingredients.

Methods: The study was executed in the nutrition Lab of Amity University Gurugram, during 2023-2024. The main ingredients used in developing the soup were Malted barley flour, Oats, amla powder, sweet potato starch and spices. The four products, namely E1, E2, E3 and E4, have been developed using these ingredients. The combination for E1, E2, E3 and E4 contain Malted barley, oats powder and amla powder in the combination of (40+40+5) g, (48+32+5) g, (56+24+5) g and (64+16+5) g. All the developed food products passed the hedonic rating test for sensory evaluation. The highest-scored sample was selected and taken for the nutritional analysis.

Result: Based on the sensory evaluation scores given by the subjects, E1 is the most preferred one with a high scale of 8.0±0.94 followed by E2 with 7.6±0.69, E3 with 7.5±0.97 and E4 with 6.9±1.1. The nutritive value of the best-rated sample (E1) was found with the energy 148.58 Kcal, carbohydrate 28.65g, protein 5.04g, fat 1.79g and dietary fiber 5.59 g. The result showed that the formed soup was rich in dietary fiber and protein which would help to reduce energy intake and help to maintain body weight and can be taken as nutritious healthy soup.

Key words: Barley, Food products, Gooseberry, Oatmeal, Soup.

INTRODUCTION

Nowadays, people are living hectic lives due to urbanization. They do not have enough time to cook food and so they are becoming accustomed to consuming fast foods. These foods are mostly junk foods and contain high sugar, salt, fats, unhealthy additives and low values of nutrients in terms of protein, fiber, vitamins and minerals. Several food products have been developed with an idea of fortification to fulfill the daily day nutrient requirement (Hareesh, 2024; Bansal *et al.,* 2022).

The consumption of these foods, which are depleted in nutrients, eventually leads to malnutrition and related diseases. Furthermore, cereal-based diet models can also exaggerate this condition. This problem can be solved by providing easy-to-cook nutritional foods (Verma *et al.,* 2018). Vegetable-rich soups are a great nutritional choice because they contain low energy and high nutrient density. These products contain an important quantity of balanced nutrients, including vitamins and minerals and contain relatively low calories. Dry soup powder has the advantage of protecting the enzymatic and oxidative deformation and taste stability at ambient temperature for a long period (6-12 months). However, most locally available soups do not meet the standards of nutritional quality. Food quality can be improved by introducing sources of protein, minerals and vitamins from plants suitable for all types of people. Based on these, barley flour, oats, amla powder and spices would be a good source for their high nutritional quality.

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Millet is a starchy grain that is abundant in nutrients and includes several vitamins and minerals. Millets are abundant in nutrients and dietary fiber. They are rich in protein, vitamins and phytochemicals. The millets provide 7-12% protein, 2-5% fat, 65-75% carbs and 15-20% dietary fiber. Millet protein has a superior essential amino acid profile than maize and other grains.

Health benefits of millets

Millets offer a number of nutraceutical qualities that can help to avoid a range of health issues, including lower

blood pressure, cardiovascular risk, cancer prevention and heart disease, as well as decreased tumors incidence (Gupta and Gupta, 2023). The health benefits of the millet have been illustrated in Fig 1.

Millets and diabetes

In the millet-consuming population, there was a reduction in diabetes incidence. The control of blood glucose levels by finger millet effectively improves antioxidant status and accelerates the healing process of skin injuries in diabetic rats (VP *et al.,* 2024).

Millets and cardiovascular disease

Millets are a good source of magnesium that can reduce the effects of migraines and heart attacks. Millets are rich in phytochemicals that contain plant acids known for lowering cholesterol. Finger Millet can prevent cardiovascular disease by reducing plasma triglycerides in high-lipidemic rats (Kumar *et al.,* 2023).

Millets and celiac disease

Celiac disease is an immune-mediated inflammatory disease induced by the intake of gluten in genetically sensitive people. Millets are gluten-free and are therefore an excellent choice for patients with celiac disease and gluten-sensitive patients, who are often irritated by gluten content in wheat and other common cereals (Asrani *et al.,* 2023).

Millets and cancer

However, millets are rich in phenolic acids, tannins and chemicals and are known as antinutrients. It has been shown that millet phenolics are effective in preventing *In vitro* cancer initiation (Gupta and Gupta, 2023).

Millets and anti-inflammatory activity

Ferulic acid is a very powerful antioxidant, free radical absorption and anti-inflammatory activity. Antioxidants are used to greatly prevent tissue damage and stimulate the healing process of wounds. In diabetes-induced rats, the antioxidant effect of finger millet on the skin healing process is reported to modulate inflammation through oxidative stress (Mokal, 2024).

Finger millet (*Eleusine coracana*)

- The finger millet shows a high amount of calcium (0.34%), protein (6-13%), dietary fiber (18%), minerals (2.5-3.5%), phytates (0.48%) and phenolics (0.3-3%)
- It shows various health benefits such as anti-diabetic, antiulcer, anti-inflammatory, antidiarrheal, antitumorigenic, antimicrobial, rich in antioxidants and helps in preventing atherosclerosis (Kazi *et al.,* 2022).

Barley (*Hordeum vulgare)*

- Barley was first recognized as a rich and high-energy food. For example, Roman gladiators were called hordearii or barley men for eating barley to give them strength and stamina.
- Total barley consists of about 65-68% of starch, 10-17% of proteins, 4-9 per cent of β-glucan, 2-3 per cent of free lipids and 1.5-2.5 per cent of minerals. The total amount of dietary fibers ranges from 11 to 34 per cent and the total amount of soluble dietary fibers from 3 to 20 per cent.

Oats (*Avena sativa*)

- Oats (*Avena sativa*) have been particularly studied for their high content of food fibers, plants and nutritional value. It is believed that eating oats has various health benefits, such as a low cholesterol rate, anticancer effect and celiac patients' diet.
- The study and development of oats and their products can help to fight various diseases that are known to mankind (Rasane *et al.,* 2015).

Amla fruit (*Emblica officinalis*)

- Amla is a highly nutritious and rich source of vitamin C, amino acids and minerals. It contains several chemical components such as tannin, alkaloids and phenols.
- The vitamin C content of amla varies from 206.8 mg to 932.1 mg/100 g (Alkandari *et al.,* 2019).

Aims and objectives

- To develop high dietary fiber, high protein and low-calorie soup.
- To Standardize the ingredients for the development of soup.
- To assess the organoleptic evaluation of the developed product by 9-point Hedonic Test.
- To identify the nutritive value (Carbohydrate, Dietary fiber, protein, fat and energy) of the developed product soup.

MATERIALS AND METHODS

Food processing techniques applied for the finger millet processing

Food processing techniques are used to improve nutrition quality, improve food nutrient digestibility and bioavailability and reduce antinutrients (Kulthe *et al.,* 2022). Some food technologies are decoration, milling, freezing, cooking, germination, fermentation, malt, popping, *etc.*

Soaking

Soaking helps to reduce the amount of important anti-nutrients such as polyphenols and phosphates, increases protein digestion *in vitro* and improves the bioavailability of minerals such as iron and zinc.

Germination

The germination of the millets (*Pennisetum typhoides*) reduced the level of tannin (1.6% to 0.83%). The process of germination improved the digestibility of pearl millet and improved the *in vitro* protein (14% to 26%) and starch (86% to 112%) (Sehgal and Kawatra, 2001).

Malting

Malting increases moisture content to the necessary level for starting germination, changing kernel germination and

drying (Baranwal, 2017). A study conducted by Davana *et al.* (2021) also reported that the malting process helps in the reduction of antinutritional factors and improves the nutritional content of the grain (sorghum).

Procurement of raw materials

The study was executed in the nutrition Lab of Amity University Gurugram, during 2023-2024. The main ingredients used in developing the soup were Malted barley flour, Oats, amla powder, sweet potato starch and spices. The four products, namely E1, E2, E3 and E4, have been developed using these ingredients. The soup recipe was standardized using the following ingredients:

- Standardization of food products.
- Finger millet and malted barley (50-50 ratio).
- Oats (*Avena sativa*).
- Amla powder.
- Spices.

Development of the product (soup)

Malted barley flour, oats, amla powder, sweet potato starch and spiceswere used to prepare a product common in India. Dietary fiber-rich, low glycemic soup powder was prepared in the amount of 100 grams from the below-mentioned ingredients.

Standardization

Standardization of the recipe includes the preparation of the recipe by keeping each and every factor in mind like the temperature, location, presentation, taste, approved testing, *etc.* so that every time it is cooked should be identical to the previous one. The standardization of the ingredients mentioned in the Table 1.

Process of preparation of soup

The millet soup has been prepared by using malted finger millet and barley seed as a main ingredient. The process of the preparation is as follows:

- Finger millet and barley seeds were washed properly with running tap water followed by soaking at room temperature (at 32°C) overnight (10 hours) in a glass bowl. This soaking process will help to reduce the anti-nutritional content of the grains.
- After that water was drained off and then soaked the excess water properly with the help of tissue paper, then keep all the soaked seeds in the muslin cloth for again 10-12 hours at room temperature till sprouting. This sprouting process also reduces the anti-nutritional content of the seed and improves the nutritional content of the seeds and the digestibility of the seeds for further digestion.
- After the sprouting, the malting process has been adopted, so that the further enzymatic reaction should stop and the degradation of the protein. The malting process is conducted in the hot air oven for 2 hours at 32°C.
- After the malting both barley and millet, were grounded into fine powder with a grinding machine at the RPM of 2000 for 2 minutes.

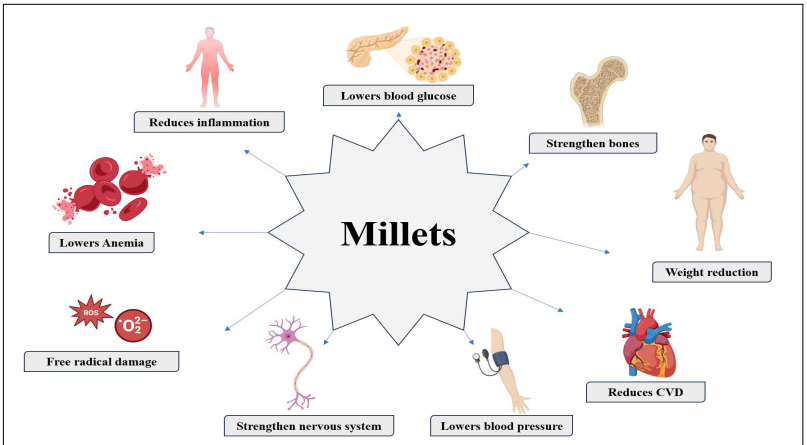

Fig 1: Role of millets in various health diseases.

Table 1: Ingredients used in the preparation of newly developed fiber-rich soup.

Experimental products	Treatments				
	Malted barley and Finger millet (50:50) (g)	Oats powder (g)	Amla powder (g)	Spices (g)	Sweet potato Cornstarch (g)
E1	40	40	5	5	10
E2	48	32	5	5	10
E3	56	24	5	5	10
E4	64	16	5	5	10

- Then sweet potatoes were washed properly and cut into fine slices. After that, all the slices were ground into a fine paste. The milk was extracted from the fine paste of sweet potato and then let the milk settle for a night, so that the starch could sediment down the bowl. Then the starch was extracted and sun-dried for a day. Then the starch was ground to fine powder with the help of a grinding machine. Then the powder was sieved with the help of a sieving machine of the pore size 50 μm.
- Then the Fresh amla was washed properly and chopped into fine slices and the fine slices were dried in the hot air oven at 50°C for 3 hours.
- Then the oats milk was extracted by soaking the rolled oatmeal in potable water for 1 hour, then grinding it with the help of a grinding machine and extracting the paste with the help of muslin cloth. The oat milk was extracted.
- Then the desired amount of the oat milk, amla powder, sweet potato starch and the millet and barley powder was taken in a bowl and mixed it with water, stirring properly so that no lumps would form. Then boiled at the lower flame over the gas, a fresh healthy millet-based soup was ready to serve. The process of preparation (flow chart and schematic diagram) and different samples has been illustrated in Fig 2 and Fig 3.

Sensory evaluation

All the four samples labelled with their sample number were kept at a serving area. Sensory evaluation forms, pen and glasses of water were also kept at the tasting station. The four samples E1, E2, E3 and E4 were tasted by 20 panelists and rated them according to 9 Point Hedonic scale. Each individual gave its rating on the basis of his likes or dislikes. After conducting the sensory evaluation, statistical analysis was done. The sensory evaluation of each four samples of millet soup is illustrated in Table 2.1, Table 2.2, Table 2.3 and Table 2.4.

Proximate analysis of the product by various methods

The food that we eat, should be known about its nutritional composition. The AAC 2005, method was used to calculate the nutritional analysis of the developed product. The

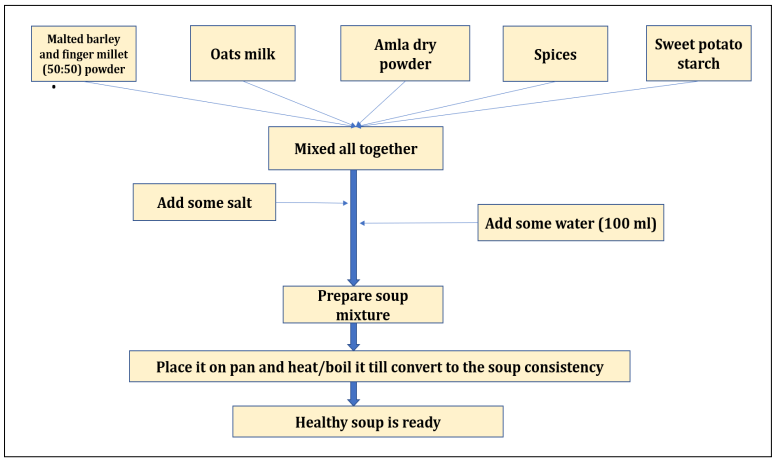

Fig 2: The schematic flow chart of the process of the preparation of millet soup.

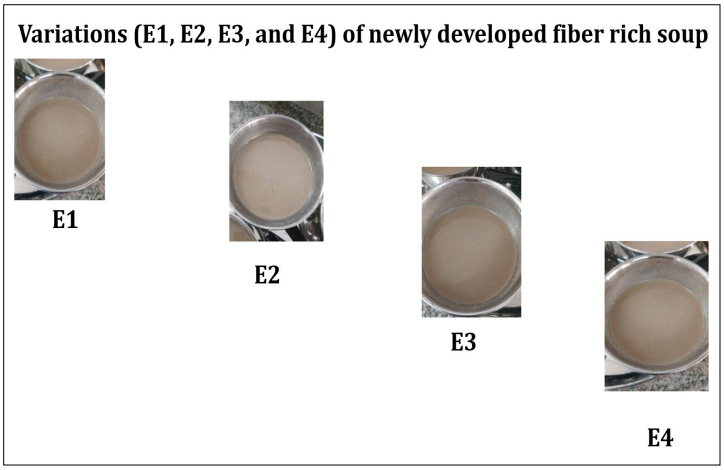

Fig 3: The variation of the sample developed for millet soup.

carbohydrates, protein, fats, dietary fiber and energy of the food product were calculated for 100 g samples.

Carbohydrate analysis

Carbohydrate analysis was done using the Antrone method, the Micro-Kjeldahl method was used for the estimation of proteins and for the estimation of fats Soxhlet apparatus method was used in the product.

Energy

Energy was calculated by multiplying proteins and carbohydrates by four multiplying fats by nine and adding up the values of three.

Dietary fiber

The Enzymatic-Gravimetric method was used for dietary fiber content calculation.

Table 2.1: Sensory result of sample E1.

Parameters/Subjects	Appearance	Colour	Taste	Aroma	Consistency	Overall
I	8	8	8	8	7	8
II	9	9	9	9	9	9
III	9	8	9	7	9	8
IV	6	6	7	7	7	7
V	7	6	6	6	7	6
VI	7	8	8	7	8	8
VII	9	9	9	8	9	9
VIII	8	8	7	9	9	9
IX	9	8	8	9	9	8
X	9	9	8	7	9	8
Mean	8.1	7.9	7.9	7.7	8.3	8.0
SD	1.1	1.1	0.9	1.05	0.94	0.94

Table 2.2: Sensory result of sample E2.

Parameters/Subjects	Appearance	Colour	Taste	Aroma	Consistency	Overall
I	7	7	7	7	8	7
II	7	7	7	7	7	7
III	9	8	8	7	9	7
IV	6	6	7	7	7	7
V	7	7	7	6	7	7
VI	7	7	7	8	7	8
VII	8	9	8	8	9	8
VIII	8	8	6	9	9	9
IX	8	8	8	9	8	8
X	8	8	8	7	8	8
Mean	7.5	7.5	7.3	7.5	7.9	7.6
SD	0.84	0.84	0.67	0.97	0.87	0.69

Table 2.3: Sensory result of sample E3.

Parameters/Subjects	Appearance	Colour	Taste	Aroma	Consistency	Overall
I	9	9	9	9	9	9
II	6	6	6	6	6	6
III	9	8	8	7	9	7
IV	6	6	8	7	8	8
V	7	5	6	6	6	6
VI	7	7	7	7	7	7
VII	8	9	8	8	9	8
VIII	8	8	5	9	7	8
IX	8	9	8	9	9	8
X	8	7	7	8	8	8
Mean	7.6	7.4	7.2	7.6	7.8	7.5
SD	1.07	1.4	1.2	1.17	1.2	0.97

Table 2.4: Sensory result of sample E4.

Parameters/Subjects	Appearance	Colour	Taste	Aroma	Consistency	Overall
I	6	6	6	6	6	6
II	6	6	6	6	6	6
III	9	8	8	7	7	6
IV	6	6	9	7	9	9
V	6	5	5	6	7	6
VI	7	7	6	6	7	6
VII	8	9	8	8	9	7
VIII	8	8	9	9	7	8
IX	8	8	8	9	8	8
X	8	7	6	8	8	7
Mean	7.2	7	7.1	7.2	7.4	6.9
SD	1.1	1.2	1.4	1.2	1.07	1.1

Table 3: The cumulative sensory result of the four samples of the millet soup.

Attributes	E1	E2	E3	E4
Appearance	8.1±1.1	7.5±0.84	7.6±1.07	7.2±1.1
Colour	7.9±1.1	7.5±0.84	7.4±1.4	7±1.2
Taste	7.9±0.9	7.3±0.67	7.2±1.2	7.1±1.4
Aroma	7.7±1.05	7.5±0.97	7.6±1.17	7.2±1.2
Consistency	8.3±0.94	7.9±0.87	7.8±1.2	7.4±1.07
Overall	8.0±0.94	7.6±0.69	7.5±0.97	6.9±1.1

Table 4: The nutritive value of the best sample of the developed millet soup.

100 gm of soup contains	
Nutrient	Amount
Energy (Kcal)	148.58
Carbohydrate (g)	28.65
Protein (g)	5.04
Fat (g)	1.79
Dietary Fiber (g)	5.59

Crude fat

The method of fat extraction was followed by AOAC 1995.

Protein content

Micro Kjeldahl Method The estimation of various flours was done by the Micro Kjeldahl method as described in A.O.A.C. (2000). The following formula was used:

$$N\ (\%) = \frac{1.4(V2 - V2)\ \text{Normality of HCl} \times 250\ (\text{dilution})}{\text{Weight of sample}}$$

Where,

(V2 - V1) = Volume made of the digest.

Protein % = N% × Conversion factor (6.25).

RESULTS AND DISCUSSION

Organoleptic evaluation test result

After conducting the sensory evaluation, the products were statistically analyzed using mean and standard de*via*tion. The average sensory evaluation value of the various sensory attributes like Appearance, Color, Taste, Aroma, Consistency and Overall Acceptability of millet soup. The average sensory score of millet soup in relation to appearance found highest in E1 (8.1±1.1), followed by E3 (7.6±1.07), E2 (7.5±0.84), E4 (7.2±1.1) respectively. The average sensory score of millet soup in relation to color found highest in E1 (7.9±1.1), followed by E2 (7.5±0.84), E3 (7.4±1.4), E4 (7.0±1.2) respectively. The average sensory score of millet soup in relation to taste found highest in E1 (7.9±0.9), followed by E2 (7.3±0.67), E3 (7.2±1.2), E4 (7.1±1.4) respectively. The average sensory score of millet soup in relation to aroma found highest in E1 (7.7±1.05), followed by E3 (7.6±1.17), E2 (7.5±0.97), E4 (7.2±1.2) respectively. The average sensory score of millet soup in relation to consistency found highest in E1 (8.3±0.94), followed by E2 (7.9±0.87), E3 (7.8±1.2), E4 (7.4±1.07) respectively. The highest-scored sample was selected and taken for further studies. Based on the sensory evaluation scores of overall acceptability given by the subjects, Sample E1 is the most preferred one with a high scale of 8.0±0.94 followed by E2 with 7.6±0.69, E3 with 7.5±0.97 and E4 with 6.9±1.1. The cumulative sensory evaluation and overall results have been illustrated in Table 3 and Fig 4 shows the spider graph of all attributes.

The proximate analysis result of newly developed fiber-rich millet soup

The nutritive value of the best sample (E1) showed that the developed millet soup contained calories 148.58 Kcal, 28.65 g of carbohydrates, 5.04 g of protein, 1.79 g of fats and 5.59 g of dietary fiber. The proximate analysis result has been illustrated in Table 4.

A study conducted by Tulasi *et al.* (2020) reported that millet-based instant soup mixes contain quite high

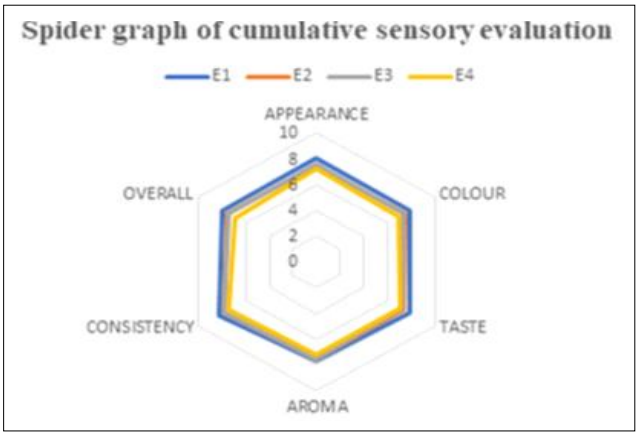

Fig 4: The cumulative sensory evaluation graph of all four samples of various attributes of millet soup.

carbohydrate content of 84.42%, 83.71% and 82.14% in the T0, T1 and T2 samples, that shows our soup sample contains very minimum amount of carbohydrates, which would be effective for the health-conscious people. Another study reported that the multigrain soup sticks had a 15.30 g protein content, 12.14 g of fat and quite a high amount of carbohydrate 63.79 g (Wadikar *et al.,* 2022). A similar study conducted by Kaur and Das (2015), reported that Barley flaxseed functional dry soup mix containing carbohydrates of 54.70% and fat of 8.70% which is quite higher than our soup product, whereas the crude fiber content of 4.84% which is less than our soup premix. It was a low glycaemic soup, free of antinutritional risk and had a very low calorific value of 148.58 kcal/100 g estimated from its composition than the other soup premix.

CONCLUSION

Millets are the main source of food that not only provides important nutrients such as proteins, carbohydrates and fats. It also provides a large amount of vitamins and minerals. In developing countries, obesity, diabetes, cardiovascular disease, skin problems, cancer, diabetes, *etc.* are the most prominent health problems due to lack of nutrition. As per the result, the sample E1 was rated best among all four samples in terms of color, texture, mouthfeel, appearance and overall acceptability. In view of the findings obtained by the current research, it could be concluded that soup is good and effective for obese as well as for constipation patient as they contain a good amount of protein and fiber. The formed soup was rich in dietary fiber and protein which decreases energy intake and helps to maintain constipation and body weight.

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Not applicable.

Disclaimers

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Informed consent

Not applicable.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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