

## Impact of the oncological treatment on change in taste perception and dietary habits of children diagnosed with cancer – preliminary study

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### ABSTRACT

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**Purpose:** Chemotherapy, which is widely used in cancer treatment in children, may cause various side effects, including impaired taste perception, thus the main aim of the presented study was a subjective assessment of changes in taste perception and dietary habits among children undergoing oncological treatment.

**Materials and methods:** In the present study, 41 hospitalized children were examined (mean age 11.0 ± 5.1 years). Anthropometric measurements were made, and diet was assessed using a food frequency questionnaire.

**Results:** For 85.4% of the patients, the current treatment was chemotherapy. The average Body Mass Index value was 17.8 kg/m<sup>2</sup>. 68.3% of children

declared a change in taste preferences preferred tastes were spicy (39.3%) and sour (35.7%). Determination of the way of eating showed a significant reduction in the consumption of bread, milk and dairy products, poultry, meat, fish, potatoes, vegetables, and a particularly pronounced decrease in the frequency of sweets consumption.

**Conclusions:** Oncological treatment changes the subjective taste perception of children in favor of intense flavors, and the process of oncological treatment, especially the use of chemotherapy, affects the way of eating.

**Keywords:** taste changes, pediatrics, nutritional status, oncological treatment, dietary habits

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## **INTRODUCTION**

In Poland, the incidence of cancer among children aged 0-18 years old has slightly increased over the past decade. The incidence rate in this age group, for both sexes, is approximately 11-13 per 100,000 [1]. Most frequently occurring among young children (age 0-14) cancer types are acute leukemia and brain tumors, during adolescence (age 15-19) lymphomas, brain and bone tumors [1, 2]. In most cases, childhood cancers are curable – about 80% of children and adolescents recover, in some types of cancers this percentage reaches over 90% [2,3]. Generally, the use of effective treatment methods allows reducing mortality. These include early detection of neoplastic disease, enhanced and multidimensional treatment, and improved care over the patients, also prevention and combating infections [4].

First symptoms of neoplastic disease among children depend on the type and location of the cancer. In leukemia, recurrent infections are frequent, whereas lymphomas are characterized by the presence of a perceptible tumor, which is sometimes accompanied by neurological symptoms, especially when the tumor is located in the central nervous system. Bone pain, often confused with the pain accompanying the growth period, is typical for bones and soft tissues sarcoma. Development of the disease can affect the inhibition of psychosomatic development, loss of appetite, susceptibility to fatigue, restlessness and irritability [2]. Appetite loss is strongly connected with impaired taste perception. Patients often report a reduction in sensitivity to taste and smell, as well as an unpleasant metallic and/or bitter taste in the mouth [5]. Both taste and smell are somatosensory feelings which are closely related to each other during eating, thus it is challenging to determine which one is specifically responsible for changes in taste perception [6]. Important factors affecting appetite are ulcers in the mouth and throat, resulting from the intensive oncological treatment [7].

Along with impaired appetite and reduced food intake among cancer patients increases the risk of malnutrition. In clinical trials, pediatric patients with cancer undergoing chemotherapy, have significantly lower oral intake of energy and nutrients than their age-dependent requirement [8, 9].

Literature data suggest that up to 46% of children and adolescents with malignancy experience malnutrition, especially protein-caloric, due to numerous factors related to the illness itself and the treatment process [10]. It is believed that a reduced nutritional status may contribute to a decrease in the immune system function, delayed wound healing and drug metabolism disorders, which affects the patient's prognosis. Prevention of

malnutrition is important because it maintains the effectiveness of the body's defenses [11].

The main aim of the presented study was a subjective assessment of changes in taste perception among children undergoing oncological treatment. Moreover, the dietary habits of the examined children and their nutritional status were assessed using basic anthropometric parameters.

## **MATERIALS AND METHODS**

### **Study group**

The presented study was conducted May–June 2013 and was re-conducted from February to October 2018 with the permission of the local Bioethics Committee number KB/173/2013.

In total, 41 hospitalized children were qualified to the study. Informed consent was obtained from all individual participants included in the study. Children were hospitalized in the [blinded for review]. The reason for hospitalization was cancer disease. The most common (in 41.5 % of children) was leukemia, among which lymphoblastic leukemia affected 11 participants. The diagnoses also included: Hodgkin's lymphoma (4 patients), neuroblastoma (3 patients), brain tumor (3 patients), abdominal tumor (2 patients), Ewing sarcoma, cerebellar tumor, spinal tumor, testicular tumor, thigh bone tumor, Wilms' tumor, melanoma, medulloblastoma, malignant tumor of the middle ear, kidney, peripheral nerves, retinoblastoma. Recruitment to the study was based on a random selection. All participants were subjected to chemotherapy during cancer treatment, in some cases additional radiotherapy or surgical treatment.

### **Questionnaire**

The study was based on a survey questionnaire. It was filled in the presence of a child's parent/guardian ad litem and a member of the research team. The questionnaire consisted of three parts. The first one provided basic information about age, sex, place of residence, type of disease and treatment. The second part of the questionnaire was a nutritional interview concerning the frequency of consumption of selected food products, before and during oncological treatment. Patients determined the frequency of consumption as "almost daily", "at least once a week", "2-4 times a month" or "never". The last, third part of the questionnaire, was intended to provide additional information on the consumption of additional formulas, oral nutritional supplements (ONS) or other unconventional food products, and also the subjective feelings of patients regarding changes in taste preferences. Retrospectively, from medical records, information was obtained on the basic anthropometric measurements such as weight and height. Having these two measurements, the Body Mass Index (BMI) was

calculated in accordance with the guidelines of the World Health Organization (WHO).

**Statistical analysis**

Statistical analyses were performed at the 0.05 significance level ( $P < 0.05$ ).

Normal distribution was tested using the Shapiro-Wilk test; it was necessary to use non-parametric tests.

In the assessment of differences in the average level of the numerical variables in two populations, the Mann-Whitney test was used, while in the analysis of variables having the character of qualitative data, the Pearson’s chi-squared test was used.

Statistical analysis was performed using STATISTICA 12.5 (version 12.5, StatSoft, Palo Alto, USA).

**RESULTS**

**Study group**

For the majority of study participants (85.4%), the current treatment was chemotherapy (n=35, 19 boys, 16 girls), and for 14.6% of children (n=6, 2 boys, 4 girls), a combination of chemo- and radiotherapy. Participants did not differ in terms of applied therapy ( $P = 0.343$ ). More than 1/3 of respondents (36.6 %, n=15) did not receive any oncological treatment yet, because they had a newly diagnosed disease. Among patients with an oncological medical history, chemotherapy was most frequent (51.2 %). Mean age of the study participants was  $11.0 \pm 5.1$  years (min-max: 1.7 – 18.8 years old). 51.2% of the study group was boys, and 48.8% girls.

**Table 1.** Basic characteristics of study participants

Parameters	Study group n=41	Boys n=21	Girls n=20	P
Age, y, x ± SD (95.0% CI)	11.0 ± 5.1 (9.4-12.6)	12.2 ± 4.6 (10.1-14.3)	9.8 ± 5.3 (7.3-12.3)	0.118
Age, y				
0-2	2.4% (1)	–	5.0% (1)	0.019
3-10	43.9% (18)	33.3% (7)	55.0% (11)	
11-18	53.7% (22)	66.7% (14)	40.0% (8)	
Place of residence, thousands of residents				
village	58.5% (24)	61.9% (13)	55.0% (11)	0.969
city <50	22.0% (9)	19.0% (4)	25.0% (5)	
city 50–100	4.9% (2)	4.8% (1)	5.0% (1)	
city >100	14.6% (6)	14.3% (3)	15.0% (3)	
Height, cm, x ± SD (95.0% CI)	143.0 ± 28.9 (133.9-28.9)	151.9 ± 28.0 (139.1-164.7)	133.7 ± 27.4 (120.9-146.5)	0.041*
ABW, kg, x ± SD (95.0% CI)	39.1 ± 18.3 (33.4-44.9)	45.1 ± 18.7 (36.6-53.6)	32.9 ± 16.0 (25.4-40.4)	0.033*
BMI, kg/m <sup>2</sup> , x ± SD (95.0% CI)	17.8 ± 3.2 (16.7-18.8)	18.4 ± 3.2 (16.9-19.9)	17.0 ± 3.1 (15.6-18.5)	0.179
Use of oral nutritional supplements				
yes	43.9% (18)	52.4% (11)	35.0% (7)	0.262
no	56.1% (23)	47.6% (10)	65.0% (13)	
Use of other formulas/ unconventional food products				
yes	7.3% (3)	4.8% (1) <sup>a</sup>	10.0% (2) <sup>b</sup>	0.379
no	92.7% (38)	95.2% (20)	90.0% (18)	
Preferred taste (before oncological treatment)				
sour	4.9% (2)	4.8% (1)	5.0% (1)	0.285
salty	7.3% (3)	9.5% (2)	5.0% (1)	
sweet	39.0% (16)	23.8% (5)	55.0% (11)	
spicy	9.8% (4)	14.3% (3)	5.0% (1)	
neutral	2.4% (1)	–	5.0% (1)	
none	36.6% (15)	47.6% (10)	25.0% (5)	
Preferred taste (currently, during oncological treatment)				
sour	26.8% (11)	42.8% (9)	10.0% (2)	0.088
salty	7.3% (3)	9.5% (2)	5.0% (1)	
sweet	29.3% (12)	14.3% (3)	45.0% (9)	
spicy	29.3% (12)	28.6% (6)	30.0% (6)	
neutral	–	–	–	
none	7.3% (3)	4.8% (1)	10.0% (2)	

n– number of participants, P– statistical significance at <0.05, x– mean value, SD– standard deviation, CI– confidence interval, (–)– number in brackets, ABW– Actual Body Weight, BMI– Body Mass Index; <sup>a</sup>–beetroot juice; <sup>b</sup>–flax seed (n=1), linseed oil (n=1)

There were no significant differences in the age between the two groups ( $P = 0.118$ ). Table 1 presents the distribution of basic features obtained from the questionnaire based on gender.

Most of the study participants lived in villages (58.5 %). Significant differences between groups were observed for height and actual body weight (ABW). Girls had significantly lower ABW (min-max values: 9.0 – 57.0 kg, while for boys 14.0 – 78.0 kg) and height (85.0 – 174.0 cm vs. 96.0 – 190.0 cm). Height, actual body weight, and BMI of the examined children differed significantly after the division of patients into two age ranges (3-10 years old, and 11-18 years old) (table 2). The average BMI value was 17.8 kg/m<sup>2</sup>. Analyzing fluctuations in the body mass values of the examined patients, the

percentage of body weight decrease or increase resulting from oncological treatment was also determined. 26.8 % of children had no changes in body weight, while mean weight loss of 10.1 ± 7.9% (min-max: 2.4% – 29.4%) was observed in 43.9 % (n=18) of children. 29.3 % of respondents (n=12) gained weight (6.4 ± 5.5%, min-max: 1.7% – 21.4%). All used industrial formulas were oral nutritional supplements, and their use reported almost half of the children (43.9 %). ONS consumed were standard, complete diets or formulas enriched with protein, preparations without cow's milk protein, or without dietary fiber and fatty acids, fruit flavor. A very low percentage of patients (7.3 %) used other unconventional preparations to support the treatment process (e.g. flax seed, beetroot juice).

**Table 2.** Characteristics of study participants according to age ranges

Parameters	Age 3-10 (n=18)	Age 11-18 n=22)	P
Height, cm, x ± SD	119.1 ± 16.8	165.2 ± 13.9	<0.0001
ABW, kg, x ± SD	25.1 ± 11.4	52.0 ± 12.0	<0.0001
BMI, kg/m <sup>2</sup> , x ± SD	16.7 ± 3.4	18.8 ± 2.6	0.016
Weight loss, %, x ± SD	n=5 9.6 ± 8.9	n=13 10.3 ± 7.8	0.703
Use of oral nutritional supplements, yes %			
	44.4% (8)	45.5% (10)	0.968
Use of other formulas/ unconventional food products, yes %			
	0.0%	13.6% (3)	0.476

n– number of participants, P– statistical significance at <0.05, x– mean value, SD– standard deviation, ()– number in brackets, ABW– Actual Body Weight, BMI– Body Mass Index

**Table 3.** Evaluation of taste preferences and anthropometric measurements among children declaring taste changes

Parameters	Study group n=28	Boys n=14	Girls n=14	P
ABW, kg, x ± SD (95.0% CI)	38.5 ± 19.3 (31.0-46.0)	43.7 ± 21.4 (31.3-56.0)	33.3 ± 15.9 (24.1-42.5)	0.168
BMI, kg/m <sup>2</sup> , x ± SD (95.0% CI)	17.6 ± 3.2 (16.4-18.9)	18.1 ± 3.2 (16.3-20.0)	17.1 ± 3.3 (15.2-19.0)	0.395
Preferred taste (before oncological treatment)				
sour	3.6% (1)	–	7.1% (1)	0.282
salty	3.6% (1)	–	7.1% (1)	
sweet	32.1% (9)	21.4% (3)	42.9% (6)	
spicy	10.7% (3)	14.3% (2)	7.1% (1)	
neutral	3.6% (1)	–	7.1% (1)	
none	46.4% (13)	64.3% (9)	28.6% (4)	
Preferred taste (currently, during oncological treatment)				
sour	35.7% (10)	57.1% (8)	14.3% (2)	0.112
salty	3.6% (1)	–	7.1% (1)	
sweet	17.9% (5)	7.1% (1)	28.6% (4)	
spicy	39.3% (11)	35.7% (5)	42.9% (6)	
neutral	–	–	–	
none	3.6% (1)	–	7.1% (1)	

n– number of participants, P– statistical significance at <0.05, x– mean value, SD– standard deviation, CI– confidence interval, ABW– Actual Body Weight, BMI– Body Mass Index, ()– number in brackets

In the final part of the questionnaire, patients gave information about their favorite,

preferred taste before, and currently, during oncological treatment. 13 patients (7 boys, 6 girls)

did not declare changes in their preferred tastes, thus they were excluded from the further analysis. 68.3 % of respondents (n=28), who declared a change in taste preferences, most often described their favorite taste as spicy (39.3 %) or sour (35.7 %) (table 3).

The highest percentage of children (46.4 %) before oncological treatment did not have a favorite taste. None of the patients during the oncological treatment described their favorite taste as neutral, and only one person pointed to the lack of specific preferences. There were no significant

differences in ABW and BMI between the sexes, as well as no statistically significant differences in the values of anthropometric measurements between participants who declared changes in taste, and who did not experience these changes (for ABW  $P = 0.73$ ). Also age of the study participants had no effect on declared taste changes (table 4). However, a significant difference was observed in the choice of preferred flavors before and during oncological treatment ( $P = 0.00006$ ).

**Table 4.** Impact of age and body weight on taste changes

Parameters	Study group n=41	Taste change n=28	No taste change n=13	<i>P</i>
Age, y, $x \pm SD$ (95.0% CI)	11.0 $\pm$ 5.1 (9.4-12.6)	10.9 $\pm$ 5.3 (8.9-13.0)	11.3 $\pm$ 4.8 (8.4-14.2)	0.857
ABW, kg, $x \pm SD$ (95.0% CI)	39.1 $\pm$ 18.3 (33.4-44.9)	38.5 $\pm$ 19.3 (31.0-46.0)	40.5 $\pm$ 16.7 (30.4-50.6)	0.730

n– number of participants, *P*– statistical significance at <0.05,  $x$ – mean value, SD– standard deviation, CI – confidence interval

**Analysis of the dietary habits**

Significant differences in the frequency of consuming certain food products before and during oncological treatment were observed ( $P < 0.05$ ). Frequency of consumption was assigned a point value: almost daily (3 points), at least once a week (2 points), 2-4 times a month (1 point) or never (0 points). The study demonstrated a significant reduction in the consumption of wheat bread, milk and dairy products (cottage cheese, sour cream), lean poultry, red meat, meat products (pate, ham,

sausages), potatoes, brassicas, orange, vegetables, and legumes during oncological treatment. A particularly pronounced decrease in the frequency of consumption of sweets (chocolate bars, waffles, milk desserts, cake, cookies, biscuits), yoghurt, cheese, sausages (hot-dog type), rapeseed oil, sunflower oil, and nuts was observed (table 5). The only food product for which frequency of consumption slightly increased was linseed oil (ratio 0.10/0.22,  $P = 0.201$ ).

**Table 5.** Comparison of the frequency of consumption of selected food products before, and during oncological treatment (n=41).

Food products	before/during oncological treatment ratio	<i>P</i>	Food products	before/during oncological treatment ratio	<i>P</i>
whole wheat bread	1.07/0.90	0.272	sour cream	1.00/0.78	0.028
wheat bread	2.66/2.34	0.023	olive oil	0.68/0.59	0.402
groats, rice	2.02/1.93	0.388	rapeseed oil	1.83/1.54	0.006
oatmeal	0.37/0.24	0.068	sunflower oil	1.41/1.12	0.003
milk	2.44/2.12	0.025	linseed oil	0.10/0.22	0.201
yoghurt	2.22/1.78	0.008	potatoes	2.59/2.15	0.010
cottage cheese	1.39/1.17	0.041	brassicas	1.51/1.20	0.010
cheese	1.90/1.56	0.004	green vegetables	1.24/1.15	0.388
processed cheese	1.34/1.17	0.153	orange vegetables	1.71/1.46	0.028
eggs	1.83/1.78	0.789	legumes	0.71/0.44	0.012
lean poultry	2.24/1.95	0.029	citrus fruits	1.59/1.39	0.085
fatty poultry	0.20/0.10	0.067	other fruits	2.22/1.88	0.011
red meat	1.78/1.41	0.022	nuts	1.22/0.73	0.001
sea fish	1.05/0.90	0.289	juice	2.37/2.32	0.666
freshwater fish	0.90/0.73	0.109	pudding	1.27/1.20	0.480
pate	1.32/1.00	0.011	chocolate bar	2.10/1.17	<0.001
sausage (hot-dog type)	2.00/1.56	0.003	waffles	1.95/1.29	<0.001
ham	2.07/1.78	0.033	milk desserts	1.61/1.27	0.005
sausages	1.73/1.46	0.012	cake	1.22/0.78	0.001
bacon	0.34/0.20	0.176	cookies	1.71/1.20	0.001
butter	2.44/2.24	0.332	biscuits	1.51/1.15	0.005
margarine	1.10/0.98	0.249			

*P*– statistical significance at <0.05

## **DISCUSSION**

In the present study, a subjective change in the taste sensation was observed in 68.3 % of patients. There was a statistically significant difference in the choice of preferred flavors before, and during oncological treatment ( $P = 0.00006$ ). Among patients who declared a change in taste sensation ( $n=28$ ), the preferred taste was spicy (39.3 %) and sour (35.7 %), regardless of gender. In contrast, before oncological treatment preferred taste was sweet (32.1 %) or frequently patients declared a lack of one favorite taste (46.4 %). A study conducted in Sweden [12], on a group of 21 children undergoing oncological therapy, showed that 43 % of children declared taste changes. Researchers, by performing a taste test, gave their patients food products (water, sucrose, table salt, citric acid, quinine), and then asked them to determine their taste. In all cases, the patients most often determined the taste of given products as bitter, and then as sour. This partly confirms the results obtained in our study. However, it should be remembered that the taste sensation strongly differentiates between people, and it is difficult to determine it precisely. There is no doubt, however, that young patients undergoing oncological therapy better tolerate intense flavors. In the same Swedish study, unpleasant and avoided foods, as well as food aversions were evaluated. Most of the examined children confirmed that their food choice changed after the start of chemotherapy. The consumption of meat products (red meat, lean poultry), sweets, potatoes and rice decreased [12]. Limiting the consumption of red meat, as a rich source of iron and complete protein, can have negative health consequences, and lead to the development or intensification of malnutrition [13].

Dysfunctions in taste sensation can be accompanied by weight loss, which was observed in 43.9 % of children. Observed weight loss was significant (mean value of 10.1 %), while almost 1/3 of study participants gained weight (mean value + 6.4 %). During chemotherapy, the initial phase of treatment may be followed by an increase in consumption and thus the observed increase in body weight, which, however, is not observed with all types of cancer. In the later phases of treatment, usually the energy consumption decreases along with the accompanying decrease in body weight [14].

In oncology, there is no gold standard for assessing taste and smell changes. Subjective methods, like food frequency questionnaires, may be more reliable in predicting changes in the way of eating and they should be included in nutritional assessment [15]. Due to impaired taste perception, many food products, especially meats and other products containing a lot of protein (diary, legumes), may have a bitter, metallic aftertaste causing

reduced consumption [5]. This was confirmed in this study. Significant reduced intake of milk and dairy products, lean poultry, fish, red meat, and meat products were observed. Reduced intake of red meat (before treatment – 43.9 % of patients ate it at least once a week, during treatment 34.1 % 2-4 times a month) may result from parents' intervention, who were trying to follow Polish pyramid of healthy nutrition, as well as the principles of rational nutrition and limit the consumption of red meat, due to its relationship with the occurrence of obesity, cardiovascular diseases, or colorectal cancer [16]. Examined children increased consumption of juices. Parents and patients themselves declared that since the oncological treatment was introduced, the consistency of semi-liquid or liquid dishes was better tolerated. Preferred food products were easy to swallow, not irritating the mouth and esophagus. This may explain poorer tolerance of solid foods, e.g. white bread. Also, sweets intake was significantly reduced. Oncological patients often have no desire for sweets, especially those containing a lot of chocolate, because they may cause nausea. The sweet taste threshold may be lowered or raised, so some foods appear to be too sweet or not sweet enough compared to their actual taste. In a study conducted on 52 cancer patients (age >18 years old) [17] preferences for sweet foods were intensified in the early and middle cycles of chemotherapy, while the appetite itself decreased from the beginning of treatment, which was associated with a decrease in BMI. The reduced taste function was also associated with lower calories intake. Appetite loss was significantly associated with reduced calorie consumption and reduced protein intake in the early chemotherapy cycle. Impaired taste and appetite were observed up to 8 weeks after the end of chemotherapy [18].

During completing the questionnaire of food intake, children and their parents expressed their dissatisfaction with the hospital diet. They complained about the amount of meals, their caloric density and taste, which resulted in the consumption of meals prepared by parents in homes or bought in a nearby bars. Many studies indicate a significant problem of occurrence, especially in children's hospitals, fast food restaurants, snack bars, which favors the consumption of these products [19]. During oncological treatment the hospital diet is individually planned for each patient and well balanced, so it is necessary to control the products consumed by the patients. Children with cancer are particularly vulnerable to malnutrition, due to reduced food intake consuming diets low in energy density and low quality, while at the same time their energy demands are increasing [10]. Often, the disease process, especially the presence of tumors, neuromas, and fibromas that increase the total body weight and frequently cause swelling, can mask the occurrence of malnutrition [10], which should be

taken into account when assessing the patient's nutritional status. Nutritional intervention is often necessary, and the use of high in energy and protein ONS is preferred to prevent weight loss [20].

However, our study had several limitations. First, the number of participants is small, and it would be of great benefit if the study were repeated with a larger study group. Secondly, it would be beneficial to use a validated food frequency questionnaire and to include dietary habits of the patients by conducting a 24-hour food recalls.

## CONCLUSIONS

In children, oncological treatment affects the taste sensation and as a consequence, changes in taste perception. Examined patients' preferred spicy and sour dishes, while analysis of food questionnaire showed a significant reduction in the consumption of dairy, fish, meats and vegetables – factors that can have a negative effect on the nutritional status. On the other hand, patients declared a decrease in the frequency of sweets consumption, and an increase in fruit and vegetable juices. In 2001, the Council of Europe recommendations regarding food control and nutritional status in hospitals were issued to prevent the occurrence of malnutrition. Emerging topics were the individualization of meals, involving patients in diet planning to include preferred food products, and the attitude of medical personnel to diet and nutritional therapy, which should be treated as a vital part of the treatment process and be aware of the consequences resulting from the inadequate food supply [21].

It is necessary to evaluate these recommendations, however, based on the presented study, it can be concluded that changes are needed so that patients undergoing oncological treatment can better match given diets to their preferences and changing taste sensation. In addition, for the early diagnosis and prevention of malnutrition, it is important to control and systematically evaluate anthropometric measurements according to the growth charts.

## Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study was conducted with the permission of the local Bioethics Committee Number KB/173/2013.

## Informed consent

Informed consent was obtained from all individual participants included in the study.

## Conflicts of interest

None

## Financial disclosure/funding

None

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