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Association between Metals Found in Hair and the Consumption of Candies in a Children Population

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The presence of heavy metals in food is a significant contamination concern. This issue is compounded by inadequate dietary practices, especially in early childhood. Contaminant metals have been previously documented in candy goods. Furthermore, these products possess elevated sugar levels, facilitating the onset of common ailments, including obesity and dental disorders. Candy consumption among children is notably prevalent. This study analysed the presence of Ag, Al, Au, Ba, Be, Bi, Cd, Hg, Ni, Pb, Sr, Tl, and V in hair samples from 215 youngsters using Inductively Coupled Plasma-Mass Spectrometry. The examined population often ingested one or two units of specific candy goods daily. Following a Kruskal-Wallis test on non-normally distributed data, we detected significant variability in the metal content of hair samples. A statistically significant ($p<0.05$) albeit modest association (0.01-0.40) was detected for the concentrations of Ag, Au, Ba, Be, Bi, Pb, Sr, and Tl in the hair of participants who ingested two or more units daily of specific candy types. The findings indicate that the metals identified in children's hair predominantly derive from the routine consumption of daily foods. Nonetheless, specific confectionery items may serve as an additional source of contaminating metals. Due to their elevated calorie density, absence of vital nutrients, and presence of harmful metals, regular consumption of confectionery items is inadvisable.

1. Introduction

An unhealthy diet, marked by excessive consumption of fats and sugars, coupled with a sedentary lifestyle and the intake of toxic substances like alcohol, tobacco, and synthetic drugs, is directly associated with prevalent diseases such as metabolic syndrome and various cancers (Arocha Rodulfo, 2019; Harrison, Couture, &

Lamarche, 2020; Peacock et al., 2018; Stanhope, 2016). Children represent a specific at-risk demographic, as dietary patterns are formed during the formative years of life. Nonetheless, inadequate nutrition in children frequently stems from insufficient parental knowledge coupled with advertising influences from social media (Mahmood et al., 2021). In other words, preferences and aversions formed during this age will endure indefinitely.

The visually beautiful market for sweets is highly enticing for children, frequently resulting in excessive intake of these products (Kraak & Story, 2015). Nonetheless, excessive consumption of confectionery items can lead to considerable health issues (Gasser et al., 2016; Martin et al., 2010). Candies obtain their unique characteristics by including numerous components, including flavourings, colourings, and fats, along with employing different manufacturing procedures (Gunes et al., 2022). Confectionery goods are foods predominantly composed of sugars or sweetening agents, to which additional substances such as fructose, corn syrup, colourants, binders, and humectants may be used (Winpenny et al., 2017).

Recent years have witnessed a heightened intake of specific food items, particularly confectionery products, among the paediatric population (Gasser et al., 2016; Martin et al., 2010). Elevated consumption of confectionery items correlates with a heightened risk of overweight, obesity, and oral diseases (Gasser et al., 2016; Mahboobi et al., 2021). The adverse impacts also include the displacement of healthy food consumption (Boushey et al., 2020; Jensen & Smed, 2018). These encompass fresh, minimally processed food abundant in fibre and minerals, which are vital for children's health and constitute the foundation of the Mediterranean diet (Iaccarino Idelson, Scalfi, & Valerio, 2017). Candies are significantly lacking in vital elements, including vitamins and minerals (Jensen, 2020).

Moreover, excessive intake of sweets may lead to gastrointestinal pain, flatulence, and diarrhoea (Goebel-Stengel & Mönnikes, 2014; Kumar et al., 2023). Furthermore, research indicates that increased intake of sugar and dietary additives in certain youngsters may correlate with behavioural alterations and diminished concentration (Bruce et al., 2015; Stroebele & De Castro, 2004). These impacts can adversely affect academic performance and cognitive development (Pearce et al., 2018; Yaman-Sözbir, Ayaz-Alkaya, & Bayrak-Kahraman, 2019). A proclivity for high-sugar, low-nutrient diets may elevate the risk of chronic health issues (Gasser et al., 2016; Liberali, Kupek, & Assis, 2020). Furthermore, prolonged exposure to these items can modify the composition of gut flora (Mäkinen, 2016).

Conversely, the majority of environmental issues arise from human activities that disturb ecological equilibrium, intensified by elements such as industrialisation, technological progress, overpopulation, and the improper use of natural resources (Godfray et al., 2010; Willett et al., 2019). A result of this environmental imbalance is the presence of contaminating metals in foods consumed by specific groups (Rai et al., 2019). Some metals possess nutritional value (Jomova et al., 2022), whilst others present a hazardous hazard (Zhao et al., 2022).

We previously documented the existence of contaminating metals in confectionery items (Marín-Martínez et al., 2016). The objective of this investigation was to investigate the correlation between excessive intake of confectionery products and the presence of contaminant metals in children's hair.

2. Materials and Methods

2.1. Selection of Participants

Hair samples were obtained from 380 children (ages 3-12), of both genders, residing in the municipality of Elche (Spain) and representing various ethnicities. Parents of participants were apprised of the study's aims and provided informed permission. The Ethics Committee of Miguel Hernández University approved the study. Parents and selected participants were instructed to refrain from using dyes, anti-hair loss products, revitalising treatments, or any other hair treatments during the three months preceding sample collection. This duration guarantees an ideal hair length for acquiring a viable sample for examination. Exclusion criteria encompass children below 3 years or above 12 years of age, non-residents of the municipality of Elche, and anyone who have undergone hair treatments prior to sample collection.

Children participating in the study were recruited on-site based on the aforementioned inclusion criteria. The estimated representative sample comprised 380 persons, yielding a confidence level of 95% with a 5% margin of error. Subsequent to the departure of some participants, the final examined population comprised 215 individuals. The exclusion criteria encompassed protocol violations, including lack of response, registration problems, inappropriate samples, and voluntary withdrawal from participation for personal reasons. After the selection of

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the five sampling centres, the proposal was presented to the Parents' Associations of Students, along with the Directors and Faculty members of each school, to encourage essential collaboration. Parents of participating children provided informed consent for their children's involvement in the study. Each sample was assigned a code for statistical analysis to maintain participant confidentiality. The code comprised letters denoting the acronyms of each institution, succeeded by the sequential number of each sample. The participating schools and their acronyms were: San Fernando (SF), Hispanidad (H), Victor Pradera (VP), Jaime Primero (JI), Dama de Elche (DE), and Casa Blanca (CB).

2.2. Questionnaire for the Evaluation of Confectionery Products

Candies are confectionery items primarily composed of sucrose or a blend of sugars, enhanced with flavours and colours from other ingredients and/or approved additions. The surveyed confectionery goods comprise the most readily available options for consumers in the study area, featuring 17 kinds (Table 1).

A survey was done to assess the consumption of confectionary products among children from various schools. The Principal of each centre assigned the responsibility of collecting questionnaires to teachers in various classrooms. The survey conducted among all the youngsters effectively identified the most consumed types of confectionery products and their quantities. The survey incorporated questions to evaluate sweet consumption, providing numerous response options. The survey design facilitated the collection of data concerning the quantity and type of sweets ingested by participants, in addition to the timing, location, and social context (individual or group) of their consumption. Furthermore, the mean economic expenditure on the candies and the location of their acquisition were taken into account. The items of the questionnaire are presented in Table 1. Upon completion of the survey, participants were anonymised, and the questionnaires were submitted in a sealed envelope to the Principal of each centre. Moreover, other potential environmental factors, including air quality, home drinking water, and proximity to industrial or agricultural zones, were not directly assessed, which is recognised as a methodological drawback.

2.3. Sample Collection and Processing

Children who satisfied the inclusion criteria had a tiny lock of hair excised from the occipital region of their heads. Surgical steel scissors were utilised, having been previously treated with 0.6% HNO3 for 10 minutes and subsequently cleansed with acetone. Each hair sample collected was preserved in a white paper envelope, marked with the appropriate code. The envelope was thereafter inserted into a self-sealing plastic bag for additional processing.

Given that hair grows at an average rate of 1 cm per month, and the study intends to compare groups with varying patterns of candy intake, hair samples were taken concurrently to minimise the impact of other environmental influences. Hair sampling occurred at five designated schools during a one-week duration in controlled environments supplied by each institution. Each hair sample was submerged in 200 mL of 2% Triton X-100 (Merck, Madrid, Spain) for 1 minute in an ultrasonic bath, followed by three rinses (1 minute each) with ultrapure water. Subsequently, each sample was positioned in a plastic container that had been rinsed with 0.6% HNO3 and dried for 2 hours at 60°C in a Memmert UM 500 oven (Gemini, Groningen, Netherlands). After drying, each sample was sectioned into small fragments to enhance digestion with a 0.6% HNO3 for 10 minutes. Samples were positioned in Falcon tubes and centrifuged at 5000 rpm for 5 minutes. One millilitre of 65% ultrapure nitric acid (Merck, Madrid, Spain) was incorporated into each sample. The samples underwent acid digestion for 48 hours in an extraction hood. Subsequently, they were centrifuged at 5000 rpm to sediment the undigested aggregates to the bottom of the tube and allowed to stand for an additional 24 hours. After digestion, 9 mL of ultrapure water was included to achieve a final volume of 10 mL. The concentration of HNO3 was subsequently diluted to 6.5%, which is advised for maximum performance of Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). After dilution, 5 mL of each sample was collected and preserved for later ICP-MS analysis.

2.4. Statistical Analysis

Statistical analyses were conducted utilising the R software/environment (R Core Team-2023, R Foundation for Statistical Computing, Vienna, Austria). The Kruskal-Wallis test was employed for repeated assessments of non-normally distributed data. A non-parametric comparison of means was conducted on the metal content in the hair of youngsters consuming 0, 1, and 2 or more candies. Pearson's correlation was employed and categorised as modest ($r = 0.01$-0.40). Significance was established at $p \leq 0.05$. The data's nature precludes the extraction of univariate information necessary for adjusting a multivariate model, as the data are aggregated.

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3. Results

The questionnaire outlined in Table 1 provided essential data concerning the consumption patterns of confectionery goods among participants. Subsequent to analysis, certain data were disseminated in a prior paper (Marín-Martínez et al., 2016).

Table 1: Items of the Questionnaire used in the Survey of Candy Consumption by Participants.

Personal data	Name Age Course Address Phone Sex Ethnic group
Health data	Disease Treatment
Body composition	Height/H (m) Weight/W (Kg) Body mass index (W/H^2) Bioimpedance analysis: - Fat mass (%) - Muscle mass (%) - Body water (L)
CANDY CONSUMPTION	
How often do you consume candies?	Every day Once a week 2-3 times a week 4 or more times a week Few times a month Once a month
How many candies do you consume at once?	0-2 pieces 2-5 pieces 5-9 pieces More than 9 pieces
Types of candies do you consume. Indicate how many do you consume at once of each type	Hard candies Marshmallows Gummy candies Sugar-coated chewing gum Icepop Liquorice Corn chips Chocolate-filled pastries Cream ice creams Soft candies Compressed candies (i.e. lozenges) Sugared nuts (i.e. roasted peanuts, sunflower seeds, peanuts) Sugar-free chewing gum Lollipops Potato chips Other bagged snacks Kit-Kat-style chocolates
Flavors of candies do you prefer	Anisette Apple Banana Coffee with milk Cola Cream Lemon Orange Peppermint Strawberry Tutti frutti
When do you consume the candies?	Morning Afternoon All the day
Where do you usually consume the candies?	Home School Street Others

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How do you consume the candies with?	Classmates Friends Parents Alone All
When do you consume more candies?	Monday to Friday Weekends Holidays Always
How much money do you spend each time you buy candies?	0-1euro 1-2 euros 2-4 euros More than 4 euros
Where do you buy the candies?	Corner shop near home Supermarket Corner shop near the school Specialty store
When do you buy the candies?	Going/leaving the school With friends in the evening With friends during weekends At any time
What do you pay attention to when buying candies?	Candies with my preferred flavor Candies to try new flavors Candies from TV commercials Candies bought by my parents Candies with funny wrappers For gift Because my friends buy candies Cheap candies Other reasons
Do you think that candies are not good for your health?	Yes No Why?
Additional comments	From participants From professor

Table 2 illustrates the daily consumption of specific candy products among the examined child group. A consumption value of 0 does not imply a total absence of candy consumption among participants, but rather denotes a zero consumption of the specified product. The objective was to determine if there is a correlation between the metal concentration in hair and the intake of the specified items.

Table 2: Consumption Levels Per Day of Different Candy Products in the Studied Children Population (N=215): males (n=108) and females (N=107).

Candy Product	Consumption Levels	Males (n)	Males (%)	Females (n)	Females (%)	All (n)	All (%)
Hard candies	0	71	65.7	73	68.2	144	67.0
	1	23	21.3	29	27.1	52	24.2
	2+	14	13.0	5	4.6	19	8.8
Marshmallows	0	90	83.3	91	85.0	181	84.2
	1	13	12.0	8	7.5	21	9.8
	2+	5	4.6	8	7.5	13	6.0
Gummy candies	0	60	55.6	53	49.5	113	52.6
	1	12	11.1	14	13.1	26	12.1
	2+	36	33.3	40	37.4	76	35.3
Sugar-coated chewing gum	0	62	57.4	63	58.9	125	58.1
	1	30	27.8	25	23.4	55	25.6
	2+	16	14.8	19	17.8	35	16.3
Icepop	0	95	88.0	94	87.8	189	87.9
	1	9	8.3	8	7.5	17	7.9
	2+	4	3.7	5	4.7	9	4.2
Liquorice	0	96	88.9	92	86.0	188	87.4
	1	8	7.4	9	8.4	17	7.9
	2+	4	3.7	6	5.6	10	4.7
Corn chips	0	60	55.5	54	50.5	114	53.0
	1	41	38.0	45	42.0	86	40.0
	2+	7	6.5	8	7.5	15	7.0
Chocolate-filled pastries	0	65	60.2	71	66.4	136	63.2
	1	37	34.3	27	25.2	64	29.8
	2+	6	5.5	9	8.4	15	7.0

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Candy Product	Consumption Levels	Males (n)	Males (%)	Females (n)	Females (%)	All (n)	All (%)
Cream ice creams	0	66	61.1	70	65.4	136	63.3
	1	39	36.1	35	32.7	74	34.4
	2+	3	2.8	2	1.9	5	2.3
Soft candies	0	83	76.8	85	79.4	168	78.2
	1	13	12.1	12	11.3	25	11.6
	2+	12	11.1	10	9.3	22	10.2
Compressed candies (i.e. lozenges)	0	97	89.8	89	83.2	186	86.5
	1	6	5.6	5	4.7	11	5.1
	2+	5	4.6	13	12.1	18	8.4
Sugared nuts (i.e. roasted peanuts, sunflower seeds, peanuts)	0	74	68.5	60	56.1	134	62.3
	1	29	26.9	43	40.2	72	33.5
	2+	5	4.6	4	3.7	9	4.2
Sugar-free chewing gum	0	41	38.0	39	36.5	80	37.2
	1	48	44.4	41	38.3	89	41.4
	2+	19	17.6	27	25.2	46	21.4
Lollipops	0	75	69.4	63	58.9	138	64.2
	1	25	23.2	38	35.5	62	28.8
	2+	8	7.4	6	5.6	15	7.0
Potato chips	0	33	30.6	49	45.8	82	38.2
	1	66	61.1	51	47.7	117	54.4
	2+	9	8.3	7	6.5	16	7.4
Other bagged snacks	0	82	75.9	84	78.5	166	77.2
	1	20	18.5	22	20.6	42	19.5
	2+	6	5.6	1	0.9	7	3.3
Kit-Kat-style chocolates	0	70	64.8	62	57.9	132	61.4
	1	32	29.6	37	34.6	69	32.1
	2+	6	5.6	8	7.5	14	6.5
Symbols used: 2+, consumption of 2 or more candies.							

Approximately 25% of the examined paediatric population consumes one unit of hard candies, packaged snacks, or sugar-coated chewing gum everyday. Approximately 30% of children ingest one unit of chocolate-filled pastries, lollipops, or Kit-Kat style chocolate. Conversely, 2 units per day of gummy candies are ingested by 35% of the examined population. 34% of the surveyed children ingest one unit of cream ice cream. 21% of the population consumes two units of sugar-free chewing gum, whilst 40% consumes one unit everyday. The most popular snacks are potato chips, consumed by about fifty percent of the population. Regarding preferences in confectionery, girls favoured sugared nuts and lollipops, whilst boys favoured candy and potato chips.

A minor yet notable connection was identified between contaminating metals in participants' hair and elevated consumption levels of specific candy brands (Table 3) (Appendix A). These confectionary items consist of hard candies containing Ag; cream ice creams with Au, Ba, Be, Pb, and Sr; sugar-free chewing gum with Bi; and marshmallows containing Tl. No association was identified for aluminium, arsenic, cadmium, mercury, nickel, and vanadium. A little yet significant association was observed in the hair of youngsters consuming two or more servings of cream ice cream daily, despite sodium not being classified as a contaminating metal. Although this is not the focus of the current paper, this information may be pertinent to the correlation between sodium consumption and the incidence of hypertension (Houston, 1986). Metals identified in hair samples shown significant diversity and are likely derived from routinely ingested meals and other environmental sources, including air pollution, water, and technological activities (Table 4) (Appendix B).

Analysis of food samples ingested by children from school lunches revealed the presence of metals. All students ingested identical meals at school, with the sole dietary variations arising from breakfast and dinner at home, in addition to confectionery items consumed outside of school. Consequently, we concluded that the predominant source of metals identified in the individuals' hair is dietary in nature (manuscript in process). The notable connections identified for specific metals present in the hair of certain children indicate that, alongside dietary sources, particular candy products may substantially contribute to the ingestion of contaminating metals in certain groups of children.

4. Discussion

This report emphasises a slight however continuous association between the intake of confectionary items and the presence of particular metals—namely Ag, Au, Ba, Be, Bi, Na, Pb, Sr, and Tl—in children's hair. Candies, although not the exclusive source, contribute to children's dietary exposure to trace metals in the Elche region (Marín-Martínez et al., 2016). While

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metals including Al, As, Cd, Hg, Ni, and V did not exhibit a direct correlation with candy consumption, their presence in hair samples corroborates the notion of cumulative exposure via various environmental and dietary routes, encompassing air, water, and contaminated soils (Charlet et al., 2012; Guo et al., 2020). Significantly, 344 affirmative responses concerning the daily use of two or more units of candies among 215 participants suggest that numerous children frequently consume various forms of sweets. This pattern indicates possible persistent exposure to both dietary and toxicological hazards. The overconsumption of added sugars, prevalent in these goods, correlates with obesity, type 2 diabetes, cardiovascular disease, hypertension, respiratory disorders, hepatic dysfunction, and dental diseases. All of which may emerge in childhood and continue into adulthood (Liberali et al., 2020; Mahboobi et al., 2021; Martin et al., 2010). In light of the expanding market share of confectionery items, particularly among youngsters, regulatory bodies must enhance quality standards to encompass contaminating metals in addition to nutritional composition. These metals may be introduced during production, through packing materials, or by contaminated substances such as milk or sweets (Eti et al., 2023; Khan & Khan, 2022; Redan & Jackson, 2020; Zhao et al., 2022). The presence of lead (Pb) is particularly concerning, as it is associated with packaging and antiquated plumbing systems, posing a significant hazard due to its neurotoxic effects and accumulation in bone and neurological tissue (Hon, Fung, & Leung, 2017; Kumar et al., 2020; Meyers, Woodbury, & Nelson, 2020). Likewise, exposure to mercury and its methylated derivatives can lead to significant neurological and renal impairment (Díez, 2009; Gupta et al., 2015; Vinceti et al., 2017; Yang et al., 2020). Although trace quantities of arsenic (As), cadmium (Cd), and nickel (Ni) are necessary, heightened exposure presents dangers including oxidative stress, carcinogenic potential, and neurotoxicity (Anyachor et al., 2022; Filippini et al., 2020; Genchi et al., 2020; Nava-Ruiz & Méndez-Armenta, 2011; Pohl, Roney, & Abadin, 2010; Yu & Zhang, 2017). Moreover, while aluminium in food is frequently a natural occurrence, excessive exposure has been associated with neurological disorders and detrimental skeletal effects (Colomina & Peris-Sampedro, 2017; Igbokwe, Igwenagu, & Igbokwe, 2019; Li et al., 2021). Tl, although infrequently examined, is an increasing concern owing to its bioaccumulation and multisystem toxicity (Campanella et al., 2019). Likewise, V, prevalent in the environment, may impair cognitive and metabolic functioning with extended exposure (Jaiswal & Kale, 2020). This study emphasises the necessity of considering wider environmental elements that may intensify exposure hazards. School meals, frequently differing in composition and control, may contribute to total metal intake. Moreover, contaminated water, air pollution, and closeness to industrial or polluted soils present considerable yet often neglected hazards (Charlet et al., 2012; Guo et al., 2020). From a public health and food safety standpoint, our findings underscore the imperative of including quality and safety standards into food policy, especially for items aimed at children. Regulatory frameworks must adapt to encompass not only nutritional profiles but also the quality of ingredients, production methods, and packaging materials. Adhering to contamination thresholds, improving quality control in production, and establishing effective surveillance systems are essential for product safety. Moreover, enhancing transparency via labelling and public awareness initiatives might stimulate healthier consumption patterns and cultivate safer food settings for children.

4. Conclusions

The excessive and habitual intake of candies in youngsters can adversely affect both physical and mental health due to their low nutritional content and the presence of toxic metals. Encouraging healthy eating habits from childhood is essential for facilitating optimal development and preventing long-term health issues. Conversely, the swift proliferation of novel food products complicates the regulation of all their constituents. Ongoing surveillance, the use of secure agricultural methods, and stringent regulation are crucial to alleviate these hazards. Current study indicates that health authorities ought to implement measures to restrict the presence of contaminating metals in confectionery and, more generally, throughout the entire food supply chain. Furthermore, the enhancement of nutritional knowledge should be emphasised in educational institutions and other societal organisations. Ultimately, regarding candies just as innocuous indulgences is no longer defensible. When items intended for children exhibit nutritional deficits and associated contamination hazards, they transcend mere treats and become a public health issue. The conversation should transition from individual responsibility to systemic accountability, compelling industry, regulators, and governments to maintain the highest standards of food quality and safety. Safeguarding children's health necessitates more than mere advice; it demands decisive, enforceable measures that prioritise well-being over profit. Anything inferior constitutes negligence masquerading as choice.

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Conflicts of Interest

Authors declare no conflicts of interest.

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Appendix A

Table 3: Pearson´S Correlation (significance) between Metal Hair Content and Maximal Candy Consumption (2 or more units per day).

Candy product	Ag	Au	Ba	Be	Bi	Na	Pb	Sr	Tl	Al, As, Cd, Hg, Ni, V
Hard candies	0.23 (0.03)									
Marshmallows									0.10 (0.04)	
Gummy candies										
Sugar-coated chewing gum										
Icepop										
Liquorice										
Corn chips										
Chocolate-filled pastries										
Cream ice creams		0.19 (0.04)	0.10 (0.03)	0.16 (0.04)		0.10 (0.04)	0.10 (0.04)	0.10 (0.02)		
Soft candys										
Compressed										
Sugared nuts (roasted peanuts, sunflower seeds, peanuts)										
Sugar-free chewing gum					0.10 (0.04)					
Lollipops										
Potato chips										
Other bagged snacks...										
Kit-Kat-style chocolates										

Results are expressed as means ± SEM. (*) Significant hair metal content ($p<0.05$) comparing children consuming 2 or more candy products daily (2+) *vs* none (0) or one (1) according to Kruskal-Wallis test for data non-normally distributed. Empty places: no correlation.

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Appendix B

Table 4: Metal hair content in the studied children population.

Candy product	Daily candy consumption	Al (mg g^{-1})	Ni (mg g^{-1})	Cd (mg g^{-1})	Hg (mg g^{-1})	Tl (µg g^{-1})	Pb (mg g^{-1})
Hard candies	0	7.86±8.22	0.21±0.22	0.04±0.06	3.26±3.66	0.20±5.00	2.18±3.89
	1	6.15±7.08	0.19±0.19	0.06±0.16	3.93±5.09	0.30±6,00	2.09±3.80
	2+	9.71±7.93	0.26±0.34	0.05±0.06	3.72±6.54	2.20±4.00	2.83±3.77
Marshmallows	0	7.79±8.05	0.20±0.21	0.05±0.10	3.20±3.88	2.70±5.00	2.27±4.09
	1	7.27±7.50	0.30±0.32	0.04±0.03	4.40±5.57	0.05± 2.00	1.96±1.85
	2+	6.00±7.75	0.17±0.21	0.03±0.03	5.42±7.24	0.00±0.00	1.94±2.73
Gummy candies	0	8.34±8.96	0.20±0.24	0.05±0.11	3.63±4.67	2.60±5.00	1.91±2.33
	1	4.95±5.70	0.27±0.32	0.04± 0.05	2.21±2.31	0.09±3.00	1.30±1.16
	2+	7.46±6.88	0.20±0.16	0.04±0.07	3.61±4.36	2.30±5.00	2.93±5.60
Sugar-coated chewing gum	0	8.36±8.65	0.21±0.23	0.05±0.11	3.78±4.41	2.50±5.00	2.45±4.29
	1	6.62±7.12	0.20±0.17	0.05±0.08	3.32±4.94	2.10±5.00	1.81±1.97
	2+	6.42±6.12	0.20±0.29	0.03±0.03	2.49±2.79	0.20±5.00	1.98±4.32
Icepop	0	7.61±7.94	0.20± 0.18	0.05±0.10	3.51±4.12	2.50±5.00	2.267±3.98
	1	7.60±7.66	0.22±0.38	0.03±0.02	1.61±1.86	1.90±4.00	1.77±2.96
	2+	7.90±9.58	0.40±0.46	0.06±0.09	5.89±8.92	0.00±0.00	2.08±2.67
Liquorice	0	7.99±8.07	0.21±0.21	0.05±0.10	3.53±4.46	2.40±5.00	2.37±4.06
	1	4.13±6.04	0.22±0.39	0.02±0.01	2.38±3.59	2.10±4.00	0.88±0.90
	2+	6.14±7.43	0.25±0.19	0.04±0.04	3.83±3.24	0.00±0.00	1.41±1.23
Corn chips	0	7.16±8.01	0.21±0.23	0.05±0.11	3.93±4.99	2.30±5.00	2.02±2.75
	1	8.54±7.73	0.20±0.18	0.05±0.07	3.11±3.73	2.30±5.00	2.63±5.11
	2+	5.73±8.79	0.27±0.38	0.03±0.02	2.18±1.72	2.10±4.00	1.32± 1.11
Chocolate-filled pastries	0	7.97±8.09	0.21±0.23	0.04±0.04	3.38±3.80	2.40±5.00	2.42±4.26
	1	7.67±8.14	0.17±0.16	0.04±0.08	3.47±4.89	1.70±4.00	1.66±1.95
	2+	4.68±5.62	0.32±0.36	0.10±0.27	4.07±6.25	0.40±8.00	2.75±5.56
Cream ice creams	0	7.17±8.15	0.19±0.21	0.04±0.10	3.12±3.93	2.10±4.00	1.77±2.82
	1	8.72±7.66	0.241±0.25	0.05±0.08	4.17±5.11	2.70±7.00	1.80±1.06
	2+	3.86±5.84	0.31±0.26	0.04±0.02	2.06±1.22	0.20±4.00	3.05±5.22*
Soft candys	0	7.79±8.16	0.20±0.22	0.05±0.10	3.37±3.98	2.10±5.00	2.25±4.23
	1	6.38±6.10	0.21±0.18	0.05±0.05	4.50±6.96	2.30±4.00	2.04±1.70
	2+	7.78±8.36	0.23±0.31	0.04±0.03	3.01±3.32	3.30±5.00	2.15±2.40
Compressed	0	7.61±7.96	0.21±0.22	0.05±0.10	3.47±4.44	2.20±5.00	1.97±2.85
	1	4.20±4.51	0.13±0.11	0.02±0.02	3.84±4.91	1.10±3.00	1.55±2.52
	2+	9.55±8.97	0.26±0.34	0.04±0.04	3.13±3.22	4.1±8.00	5.00±8.96
Sugared nuts (roasted peanuts, sunflower seeds, peanuts)	0	7.60± 8.55	0.19± 0.23	0.05±0.11	3.31±4.16	2.6 ±5.00	2.13±3. 17
	1	7.90± 6.89	0.24±0.21	0.03±0.03	3.92±4.97	1.80±5.00	2.46±5.17
	2+	6.17±6.62	0.22±0.22	0.05±0.04	2.42±1.83	1.10±3.00	1.77±1.10
Sugar-free chewing gum	0	7.33±7.79	0.21±0.26	0.04±0.04	3.23±4.17	2.80±6.00	2.03±2.96
	1	7.89± 7.84	0.20±0.16	0.06±0.13	3.49±4.24	2.10±5.00	2.43±4.50
	2+	7.59±8.59	0.22±0.27	0.04±0.05	3.79±4.92	1.90±4.00	2.12±3.82
Lollipops	0	7.63±8.14	0.20±0.19	0.05±0.11	3.59±4.58	0.20±5.00	1.97±2.74
	1	6.75±6.77	0.19±0.17	0.04±0.04	3.10±4.06	2.70±6.00	2.73±5.71
	2+	10.96±10.07	0.35±0.50	0.03±0.02	3.69±3.52	2.90±5.00	2.38±3.07
Potato chips	0	8.04±8.45	0.20±0.18	0.06±0.13	3.99 ±4.73	1.90±4.00	2.70±5.21
	1	7.27±7.55	0.21±0.24	0.04±0.06	3.30±4.29	2.40±5.00	1.82±2.05
	2+	8.08± 8.57	0.24±0.34	0.02±0.01	2.12±2.35	3.10±8.00	2.62±5.32
Other bagged snacks...	0	7.69±8.19	0.20±0.22	0.05±0.10	3.48±4.22	2.0±6.00	2.32±4.23
	1	8.41±7.34	0.22±0.16	0.03±0.03	3.72±5.17	0.80±3.00	1.94±2.13
	2+	2.23±2.36	0.37±0.52	0.03±0.02	1.70±1.82	1.40±4.00	1.37±0.88
Kit-Kat-style chocolates	0	7.30±7.68	0.21±0.23	0.05±0.11	3.68±4.54	2.30±4.00	2.32±4.12
	1	8.14±8.49	0.19±0.16	0.04±0.03	3.17±4.10	2.20±6.00	1.76±2.44
	2+	8.46±8.46	0.28±0.39	0.03±0.02	2.65±3.62	2.70±9.00	3.58±6.28

Results are expressed as means ± SEM. (*) Significant hair metal content ($p<0.05$) comparing children consuming 2 or more candy products daily (2+) *vs* none (0) or one (1) according to Kruskal-Wallis test for data non-normally distribute

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