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Short Communication

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Should We Use Products Containing Chemical UV Absorbing Sunscreen Actives on Children?

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Abstract

The following short communication is not meant to definitively answer a specific question, but rather to initiate a conversation into simply understanding what chemicals we expose our children to on a daily basis and what impact it can have on their biological development. Sunscreen safety has recently been under question with numerous papers being published linking them to everything from general toxicity to endocrine disruption in a variety of species including humans. Additionally, a 2018 report from the American Cancer Society demonstrated that after 40 years of sunscreen use (1975-2014) melanoma has increased 4 fold in men and 3 fold in women. Many have speculated that the doses used in toxicology experiments are significant exaggerations of "normal use conditions", however, this paper clearly demonstrates that the long-term exposure to sunscreens in children is not an exaggeration but equivalent to what has been reported in the literature.

Keywords

Oxybenzone; Sunscreens; Endocrine disrupting chemicals; Low sperm density

Abbreviations:

UV: Ultraviolet; EDCs: Endocrine Disrupting Chemicals; NTP: National Toxicology Program; NOAEL: No Observable Adverse Effect Level; LOAEL: Lowest Observable Adverse Effect Level; PPM: Parts Per Million; g: Gram; mg: Milligram; Kg: Kilogram.

Short Communication

Global concern has been expressed about the use of chemical ultraviolet (UV) absorbers in children's sunscreen products. For example, the Swedish Research Council ruled sunscreens with oxybenzone are unsuitable for use in children under the age of two years because they lack the enzymes to breakdown the chemical [1]. Furthermore, a study that consisted of 1,196 adults and children concluded, octinoxate aggregate exposure levels for children aged 4 years or less, during the summer months, exceed the No Observable Adverse Effect Level (NOAEL) for reported thyroid endocrine disrupting effects [2] and should be avoided.

Review of 169 sunscreen products labeled for use on babies/children/family was conducted with 6 UV absorbers commonly identified-avobenzone, homosalate, octinoxate, octocrylene, octisalate and/or oxybenzone; all considered endocrine disrupting chemicals (EDCs) and all with molecular weights below 500 allowing for easier passage through human skin. Additionally, EDCs are "not species specific" [3] and can behave in a synergistic manner producing toxic effects, when used in combination, at levels below the known NOAEL [4].

To establish a cogent argument that the exposure levels and risks of these chemicals, when used as recommended, are of concern the following summary of premises are offered:

1. All six chemical UV absorbers noted are considered to be EDCs and the reactions they cause are not considered to be species specific.

2. They are used in combination or all together in sunscreen products labeled for use on "babies, children and/or family" at a common concentration (mode) of 32%.

3. They all have a molecular weight below 500, which allows them to pass through human skin.

4. Concerns have been expressed about exposure to these chemicals relating to potential systemic toxicity in children.

5. Endocrine disruptors can act synergistically together at levels below their individual NOAEL.

Knowing these facts, along with the absorption potential of a chemical we can calculate the exposure level, under normal conditions of use, and compare the dose received with the dose known to produce adverse reaction(s). For example, if we take a look at data for the chemical oxybenzone that is commonly used at 6% and has an absorption potential in humans of approximately 8% [5], we can observe the following:

The National Toxicology Program (NTP) studied oxybenzone at a variety of concentrations in a 13-week topically applied study in mice [6]. No NOAEL was observed in the study, however, the Lowest Observable Adverse Effect Level (LOAEL) tested was 22.75 mg/Kg or parts per million (ppm) which caused a significant decrease in epididymal sperm density (an endocrine disruption affect). If we take a 12.5 Kg 2 year old male child and apply 60 grams of a product that contains 6% oxybenzone over a 4 hour period (1 ounce every 2 hours), which is the recommended amount of sunscreen the American Academy of Dermatology and the FDA agree should be used to minimize skin cancer, the child would be exposed to 288 ppm of oxybenzone in just one day of outside play.

The amount of oxybenzone that has been shown to get through "adult" skin is approximately 8% and, therefore, if we take 8% of the 288 ppm exposure the child would absorb a dose of 23.04 ppm of oxybenzone or roughly the same dose that produced endocrine effects in mice.

Calculation

60 grams (amount of product applied/day)* 0.06 (6% oxybenzone in product)/12.5 Kg (average weight of 2 year child)=0.288 g/Kg or 288 mg/Kg or 288 ppm/exposure.

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288 ppm/exposure* 0.08 (8% oxybenzone absorbed topically)=23.04 ppm absorbed/day.

Another point that must be considered in order to compare the two studies is the duration of the study. In the NTP study, mice were applied for 13 weeks, which is approximately one-eighth of a lab mouse's life (average life span 2 years) and equivalent to 9.5 years of an American male's life (average life span 76 years). Therefore, in order to achieve a similar dose as in the mouse study we would have to apply 60 grams of product daily to the child for roughly 10 years. In laboratory studies the amount of test agent applied to maintain the dose over time is adjusted to accommodate for changes in weight as the animal matures. This cannot be done in human studies without applying excessive amounts of product. So, the amount applied daily to the child must become a constant (60 grams per day), causing the overall dose to decrease over time as the child grows (Table 1). Taking this into account the total dose absorbed over a 10-year period would be reduced to 13.56 ppm absorbed/day or 60% of the NTP LOAEL applied to mice.

The question now becomes would one expect to observe, in real life, the epididymal sperm density changes in humans that were observed in the NTP mouse study using the information obtained for the above example? Review of the literature indeed demonstrates such an effect. Scinicariello et al. [7] reported that environmental exposure to oxybenzone in adolescent boys (ages 12-19) was associated with significantly lower total serum testosterone levels, which would produce lower sperm density.

Since all 6 of the chemical UV absorbers used in these products are classified as EDCs and can exert similar effects because they are not species specific, we can recalculate the above equation replacing the 6% oxybenzone level with the mode of 32% or total chemical UV absorbers used in the baby/child/family sunscreen products. In doing so, we can calculate that the same 2 year old child would receive a daily dose of 1,536 ppm/exposure and using the 8% absorption data the amount of material entering the child's body would be 122.88 ppm/day of EDCs or nearly 5.4 times the topical dose that was used in the NTP mouse study. Again, taking into account a 10 year weighted dose (Table 1) 72.3 ppm of chemical UV absorber/EDCs would be absorbed daily or roughly 3 times the total NTP dose the mice received (assuming 100% absorption in mice) over the 13 week treatment period.

Lastly, it should be noted that 155 sunscreen containing lip balms/glosses were also reviewed that are directly (cartoon character based) or indirectly (various flavors) marketed to children. The mean, median and mode chemical UV absorbers (EDCs) used in these products was 15% which in an average package size of 4.2 grams will add an additional 630 ppm to a child's exposure level per each unit consumed, since 100% of what is applied to the lips is ingested.

Table 1: 10 year calculations based on age, weight and ppm absorbed of chemical UV EDC(s).

Age of male	Weight (Kg)	ppm from 6% oxybenzone	ppm from all actives
2 yrs	12.5	23.04	122.88
3 yrs	14.0	20.57	109.71
4 yrs	16.3	17.67	94.23
5 yrs	18.4	15.65	83.48
6 yrs	20.6	13.98	74.56
7 yrs	22.9	12.58	67.07
8 yrs	25.6	11.25	60.00
9 yrs	28.6	10.07	53.71
10 yrs	32.0	9.00	48.00
11 yrs	35.6	8.09	43.15
12 yrs	39.9	7.22	38.50
Mean dose over 10 years		**13.56**	**72.30**

Conclusion

In conclusion, there is a direct association of topically apply chemical UV absorbers found in sunscreen products, especially those containing oxybenzone or octinoxate, and endocrine disruptive effects observed in children and young adults under "normal conditions of use". Based on the data presented, it would appear that non nano-particle size mineral based sunscreens (zinc oxide and titanium dioxide) maybe a safer choice when trying to protect children from the damaging effects of UV rays, "in additional to" practicing sun avoidance, using protective clothing/hats/sunglasses and utilizing oversized umbrellas/cabanas when around pools or on beach vacations.

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