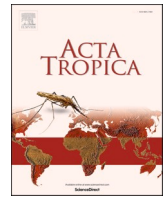




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# Head louse infestations before and during the COVID-19 epidemic in Israel

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## ABSTRACT

Head louse infestations caused by *Pediculus humanus capitis* (Phthiraptera: Pediculidae) are a public health problem in developing and developed countries worldwide. Head to head contact is by far the most common mode of lice transmission. In March 2020, WHO declared the COVID-19 outbreak as a pandemic. Starting from March 2020, the Israeli government established mandatory isolation for extensive periods including closure of school systems for very long time. The aim of the project was to compare the pediculicide sale numbers before the COVID-19 epidemic with those starting of the epidemic in 2020, as a possible marker for changing epidemiology of head lice during the COVID pandemic. Data were collected from a large pharmacy chain in Israel, which provided the actual sales of pediculicides during the years 2010–2020. During the period 2010–2019 a significant increase of pediculicide sales from 281,986 – 498,107 was observed, the highest number being from 2019. In 2020, this number dropped to 294,477, a significant drop compared to previous years and to 2019. The results of this study suggest that head louse infestations are increasing in the last years, while the extended isolation of children due to COVID-19 influenced significantly the infestation rate of children with head lice.

## 1. Introduction

Human head lice are insect parasites, spending their entire life on the human scalp and feeding exclusively on blood. Head to head contact is by far the most common mode of lice transmission. In Israel, 10–15% of all children 4–13 years old are actively infested with head lice at any given moment. An additional 10–15% of the children have nits (dead eggs or empty eggs shells) on their hair, showing that they were infested during the preceding eight months (Mumcuoglu, 1996, 1999; Mumcuoglu et al., 1990, 2018, 2021). Epidemiological studies conducted in Israel showed that infestation rate is 2–10 higher in girls than in boys, most probably associated with having longer hair, which promotes lice transmission more readily than short hair (Mumcuoglu et al., 1990, 2009; Mumcuoglu, 2021).

In March 2020, WHO declared the COVID-19 outbreak a pandemic. Starting March 2020, the Israeli government established mandatory lockdowns, including school closures, for extensive periods of time. The resulting social distancing naturally reduced direct contact between children, thus potentially affecting transmission of head lice.

In Argentina, Galassi et al. (2021) used an online survey to analyze

data from 1118 children and concluded that the prevalence of lice decreased significantly from 69.6% before the beginning of the pandemic to 43.9% during the COVID-19 lockdown.

The aim of this study was to compare the sales of pediculicides in Israel during the COVID-19 pandemic in 2020 to sales in previous years, as a possible surrogate marker for a decreased rate of head louse infestation among children, as part of a changing epidemiology of head lice during the COVID-19 pandemic.

## 2. Materials and methods

Data regarding the sales of pediculicide units during the years 2010–2020 were received from the largest pharmacy chain in Israel (SuperPharm Ltd., Herzliya, Israel) (Supplementary Table 1). Data about the total number of children at the age group of 4–13 years during the study period was retrieved from the Central Bureau of Statistics (Israel).

## 3. Results

In order to determine whether sales of pediculicides were lower in

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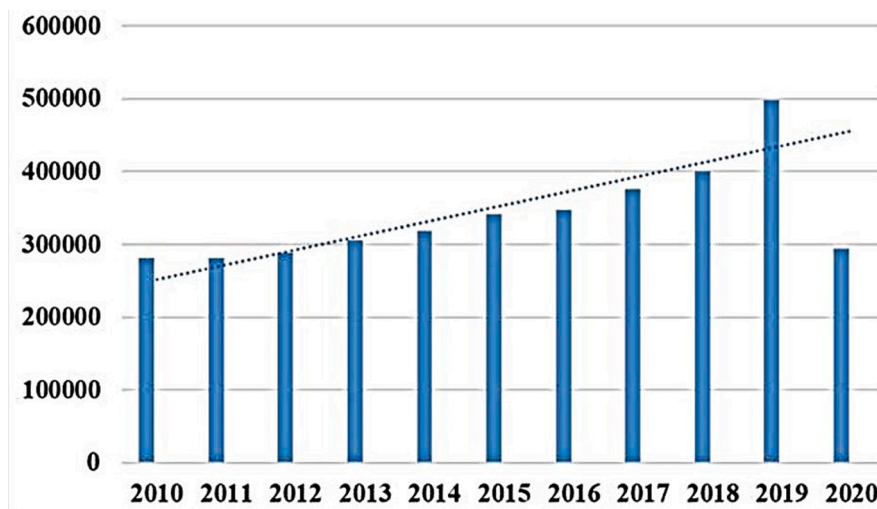


Fig. 1. Pediculicide sales during the years 2010–2020 by the SuperPharm Pharmacy chain.

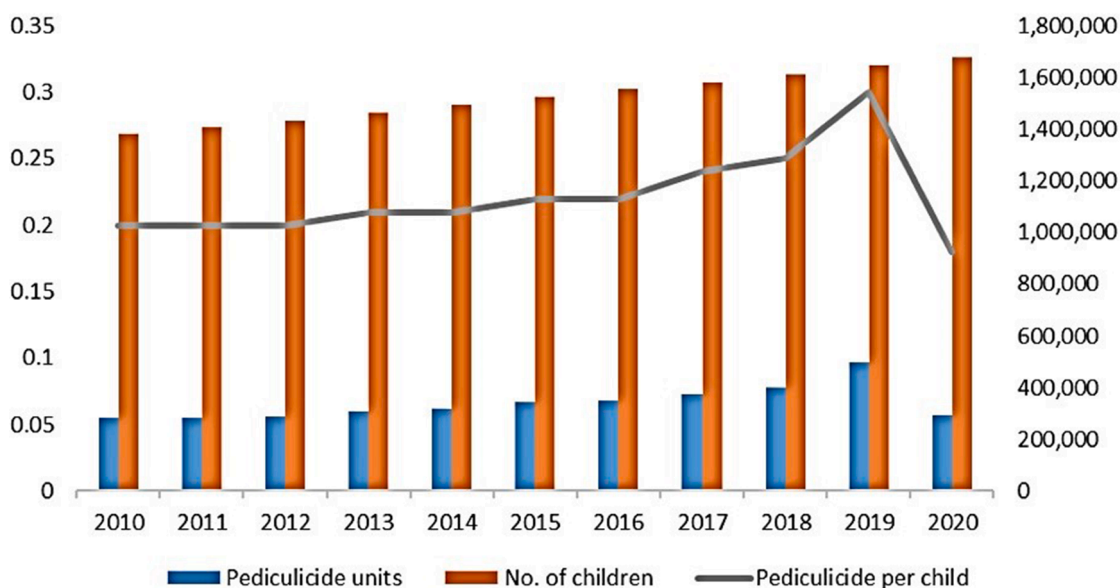


Fig. 2. Pediculicide units sold, number of 4–13-years old children and average number of pediculicide per child during the years 2010–2020.

2020 than in previous years, we collected data for the period 2010–2020 (Fig. 1). A gradual increase in sales was observed during the years 2010–2019, with numbers of pediculicide sales rising from 281,986 units in 2010 to 498,107 units in 2019, representing an average yearly increase of 8%. However, in 2020, a significant drop of approximately 40% in sales was observed, when only 294,477 units were sold.

Pediculicides are used mainly for the treatment of children aged 4–13, and in an attempt to adjust for any population changes during the period under study, we normalized the total sale of pediculicides per year by the total number of children in that age group living in Israel in that year, based on birth data published by the Israel Bureau of Statistics (2021) (Fig. 2 and Supplementary Table 2).

The value for 2019 appeared to be excessively high, and this was confirmed by a standard one-sided Grubbs test for outliers at the 1% level. The other 9 observations in the sample passed the Shapiro-Wilk test for normality ( $p = 0.3718$ ) and were then found to be very significantly higher on average than the number of pediculicides per child sold in 2020 ( $p = 3.285 \times 10^{-5}$ , as determined by a one-sided one-sample  $t$ -test) (MedCalc Statistical Software 15 November 2021).

It was clear from the raw data (both before and after normalization) that the numbers were increasing over time. A linear regression analysis of the data demonstrated that the yearly increase in the rate of pediculicide sales per child during 2010–2019 – approximately 6 pediculicides per 1,000 children per year – is statistically significant ( $p = 0.0001$ ). In contrast, the rate of pediculicide sales per child decreased from 0.3 in 2019 to 0.1 in 2020, which lies well below the 95% prediction interval calculated based on the previous years (Zar, 2010).

#### 4. Discussion

In this study, it was shown that while pediculicide sale rates in Israel constantly increased throughout the last decade of 2010–2019, it significantly dropped during 2020, coinciding with the mandatory quarantines and school closures, which were part of the national effort to control COVID-19 pandemic. A previous study by Galassi et al. (2021) evaluated the impact of COVID-19 on lice infestation rate in Buenos Aires, using an online questionnaire. Overall, 627 households with 1,118 children were included in the study and a significant decrease in

head louse infestation was reported during 2020 compared with the period preceding home confinement. The results of their study, although by a different method are in agreement with the results of our study, showing that the prevalence of head louse infestation decreased by ca. 40% during the COVID-19 pandemic in 2020.

Our present study also shows that there is an ever-growing number of pediculicide sales during the years 2010–2019 with the highest numbers observed in 2019, even if we take into consideration the ever-increasing number of 4–13-years old children during these years.

Despite the large number of pediculicides sold in the pharmacies and the prodigious efforts of parents, successful control of louse infestation in the country remains unattainable. The high prevalence of head lice is due to a variety of reasons, but the most important being that there are many ineffective pediculicides in the pharmacies, which when used according to the instructions do not eliminate the entire population of lice on the head of an infected person. To the best of our knowledge, for the majority of anti-lice products, louse repellents and nit-removal remedies there are no published studies showing that they were tested in-vivo and/or in-vitro and as a result of it they were found to be effective (Supplementary Table 3).

In order to have an idea about the overall sales of pediculicides in recent years in Israel, we requested from the distributor of Hedrin, the most used pediculicides in the country (produced by Thornton & Ross Ltd, Huddersfield, UK), to let us know what is the percentage of their sales to different pharmacies. Accordingly, approximately 50% of the Hedrin products are sold to SuperPharm (our source of information), 35% to the Health Insurance Company Pharmacies and the remaining 15% to regular pharmacies and online sales (personal communication with Rafa Company, Jerusalem, Israel). Based on these data we calculated that approximately 565,000 to one million units of pediculicides are sold yearly in Israel.

As limitations of this study it can be mentioned that our results are based on the sales of one pharmacy chain in Israel, though it is the largest one in Israel. However, we do not know whether the ever-growing number of pediculicide sales is a result of the more successful/aggressive sale strategy of the company. The strength of our study is that it reflects the entire situation in Israel.

## 5. Conclusions

The results of this study suggest that the extended isolation of children in 2020 due to COVID-19 pandemic most likely lowered their infestation rate with head lice. There are still many pediculicides in the Israeli market whose efficacy was not tested under clinical conditions and as such it is doubtful that they are effective. The Ministry of Health should implement strict conditions before a new formulation is introduced to the market and request from all the companies selling pediculicides to present proofs that their products were tested in vitro, ex vivo and/or in vivo tests. It should be taken into consideration that pediculicide with an active ingredient that is already well-established in the market, but offered for registration in formulations with different

concentrations, combined with different chemicals, or with different instructions for use, may provide markedly different results (Mumcuoglu and Miller, 1991; Mumcuoglu et al., 2021).

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None

## Declaration of Competing Interest

The authors declare that they have no conflicts of interests.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.actatropica.2022.106503.

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