Original article

Assessing parental awareness and attitudes toward leaving children unattended inside locked cars and the risk of vehicular heat strokes

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1. Introduction

Vehicular heat strokes are considered as one of the preventable causes of non-crash, vehicle-related deaths among children. The incidence of children suffering from heat-related illnesses has increased during the years [1,2]. According to the No Heatstroke Organization (USA), from 1998 to 2019, at least 809 children have died from heatstroke/hyperthermia in enclosed vehicles. Fifty-four percent of the incidences occurred when a child was forgotten and left unattended by a parent/caregiver in motor vehicles [3,4].

Children are less able to cope with high temperatures, and they are more susceptible to heat-related illnesses than adults [5,6]. The factors that make children more prone to hyperthermia are greater heat production (i.e., greater metabolic rate and greater surface area-to-body mass ratio), lower blood volume to remove heat, and lower sweat rates [7,8]. It is imperative to point out that there are remarkable differences among geographic regions when it comes to weather temperature changes [6]. For example, in comparison to Europe, the climate of Arab states in the Gulf region including Saudi Arabia is hot in the summer all over the country. The temperature can reach as high as 50 °C (122 °F) [9]. According to reports of Dubai city police, every year, there are a number of cases of unattended children in locked cars. In addition, a number of cases have been
reported to pediatric clinics of children heatstroke incidences [10].

With regard to vehicle heating dynamics, while the rays of the sun penetrate the car windows, the interior surfaces of the car heat up rapidly, especially with closed windows. In the first 30 min, there is an 80% increase in temperature [7]. This rapid increase in temperature affects the body through interrupting cellular processes, and it can lead to coma and death if there is no immediate attention [11].

Vehicular heat strokes have also been associated with use of child car seats, especially rear-facing seats. Therefore, caution must be taken not to leave the child unattended while driving. Parents/caregivers could unknowingly lock the car and leave their child asleep until they come back. This behavior puts the child at great risk of heat-related illnesses or deaths [12].

Heatstroke tragedies can be prevented by raising awareness and educating parents and caregivers. Additionally, technological interventions such as child reminders might be necessary to reduce the number of children affected.

To the best of our knowledge, no local study has been conducted to shed light on parents’ attitudes toward leaving their children unattended inside locked cars. Our study aims to assess parents’ knowledge and beliefs about vehicular heat strokes among children in addition to the prevalence and associated factors of leaving children inside locked cars.

2. Materials and methods

2.1. Study design and sampling technique

This cross-sectional study was conducted in May 2018 for a 9-month period on 209 Saudi parents in the waiting areas of the pediatric outpatient clinics at King Abdullah Specialist Children’s Hospital (KASCH). KASCH is the first specialized children’s hospital in the Kingdom of Saudi Arabia, which provides concentrated pediatric care with a bed capacity of 552. Informed consent was taken before participation in the study. Convenience sampling was used in this study to maximize enrollment of participants.

2.2. Questionnaire

A structured questionnaire was designed after literature review for data collection. The questionnaire consisted of two sections: Section A was designed to collect parents’ demographic data, and Section B was designed to assess parental knowledge and attitudes toward vehicular heat strokes as well as their awareness of the dangers of leaving the child alone in a locked car. Parents were asked to either self-complete or answer questions after the informed consent. After completion of the questionnaires, a short presentation was given by medical students, shedding light on heat strokes in children and the dangers of leaving the child alone in a locked car.

2.3. Statistical analysis

Statistical analysis was conducted using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). The data of 209 participants were summarized as frequencies and averages to characterize the study participants. Our primary outcome variable was leaving a child alone in the car where we asked the participants “Have you ever left any of your children alone in the car during a sunny day?”. To determine the factors associated with leaving children in the car, categorical and continuous variables were tested using chi-square statistic and t-test, respectively, with the outcome variable. Then, we modeled the probability of leaving the child in the car using univariate logistic regression for each variable and obtained the unadjusted odds ratios with 95% confidence interval. Further, we modeled the probability of leaving the child in the car using multivariate logistic regression including all factors. Level of significance was declared at \( p < 0.05 \).

2.4. Ethical considerations

Ethical approval was obtained from the institutional review board of King Abdullah International Medical Research Center, National Guard Health Affairs, Riyadh, Saudi Arabia.

3. Results

3.1. Demographics and characteristics of participants

One hundred sixteen (57.71%) participants were mothers, with an average age of 36 (SD \( \pm \) 8.72) years for both mothers and fathers. When asking about the education for both parents in the same family, almost half of the parents had an education level of college and higher: mothers (52.68%) and fathers (53.96%). The mean number of children the parents had was 4 (SD \( \pm \) 3.61), and their monthly income was a mean of 9638 Saudi Riyal (SD \( \pm \) 5994.3) (Table 1).

The majority of parents have never left any of their children in a locked car during a sunny day (75.12%). Seventy-nine percent of participants heard about accidental deaths secondary to leaving children inside locked cars. When assessing parents’ knowledge, the majority of them knew that infants/children are more sensitive to heat (81.34%). Furthermore, 77.40% had the knowledge of temperature increase inside vehicles. The majority of the parents in our cohort did not use a car seat (56.52%). Almost half of the parents (55.02%) had concerns regarding females driving and increased incidences of forgetting children inside locked cars. Table 2 summarizes participants’ answers to main questionnaire items.

3.2. Characteristics of participants with regard to leaving children inside the car

We found that older parents were more likely to leave the child in the car. The mean age of those who have left their children alone in locked cars was 38 (SD \( \pm \) 11.6) years compared to that of 35 (SD \( \pm \) 8.75) years of those who have never left their children. Moreover, paternal education also had an impact on the likelihood of leaving children alone in the car. Our results have shown that the higher the educational level of the father, the lower was the reported incidence of children being left in the car. An increased number of children were also found to be associated with the risk of leaving their children in the car. The mean number of children of parents who left their children in locked cars was 4.8 (SD \( \pm \) 3.8), whereas

| Variable                      | N (%)                  |
|-------------------------------|------------------------|
| Age, years, mean \( \pm \) SD | 36 \( \pm \) 8.72       |
| Relationship with child       |                        |
| Parents, father               | 85 (42.29)             |
| Maternal educational background|                        |
| College and higher            | 108 (52.68)            |
| High school or less           | 97 (47.32)             |
| Paternal educational background|                        |
| College and higher            | 109 (53.96)            |
| High school or less           | 93 (46.04)             |
| Number of children, mean \( \pm \) SD | 4 \( \pm \) 3.61     |
| Monthly income in Saudi Riyal, mean \( \pm \) SD | 9638 \( \pm \) 5994.31 |
the mean of parents who have never left their children was 3.2 (SD ± 2.2). We found that the socioeconomic status had no significant impact on leaving the children alone in the car (Table 3).

Table 4 shows that in the parent group where children were never left alone in the car, 51.7% of the parents knew that children must not be left alone in locked cars even for a couple of minutes, while in the parent group where children have been left alone in a locked car, only 10.1% (21) of the parents knew about this. Awareness of increased temperature in locked cars was higher among parents who have never forgotten their child inside a locked car, i.e., 37.2%, and 6.28%, respectively (See Fig.1).

3.3. Univariate logistic regression analysis of leaving children inside locked cars

Age was associated with increased incidence of leaving children unattended in locked cars in the univariate analysis. There was no association between maternal educational background and leaving children inside the car. However, paternal educational background was significantly associated with leaving children inside a car, with increased incidence among fathers with education of high school or less (OR 2.225; 95% CI 1.163 to 4.258). In addition, increased number of children was related to leaving children alone in a locked car (OR 1.153; 95% CI 0.959 to 1.388). Table 5 shows detailed univariate analyses of leaving children inside a locked car.

3.4. Forward stepwise multivariate logistic regression analysis of predictors of leaving children inside a locked car

In this analysis, age, maternal and paternal educational background, and number of children were not predictors of increased incidences of leaving children inside a locked car. Parents who were not knowledgeable about the fact that children must not be left alone in a locked car (even for a couple of minutes) had double the risk of leaving children inside a locked car (aOR 2.788; 95% CI 1.333 to 5.828). Table 6 details the results of forward stepwise multivariate logistic regression analysis of leaving children inside a locked car.

4. Discussion

The incidents of vehicular heat strokes are unfortunately still occurring [1,2]. This behavior of leaving children unattended by their parents inside an enclosed vehicle increases the risk of heat strokes and even death [4]. Therefore, it is important to investigate parental factors that contribute to this problem.

The purpose of this study was to assess parents’ awareness and attitudes toward vehicular heat strokes and the risk of leaving children unattended inside a locked car. A self-administered questionnaire was completed by the parents. Our results suggest that the prevalence of leaving children inside vehicles was 24.88% among mothers and fathers. Comparing this result with a study conducted by Roberts et al., [13] in which 50 mothers were interviewed and asked if they ever left their infants/children inside a

Table 2
Answers to main questionnaire items.

| Variable                                | N (%)       |
|-----------------------------------------|-------------|
| Have you ever left any of your children alone in the car during a sunny day? |
| No                                      | 157 (75.12) |
| Yes                                     | 52 (24.88)  |
| If yes, where did you leave your child in the car? |
| Minimarket                              | 23 (69.70)  |
| Hospital                                | 5 (15.15)   |
| ATM                                     | 3 (9.09)    |
| Pharmacy                                | 2 (6.06)    |
| If yes, why did you leave the child?     |
| I was away for a very short time.        | 36 (67.92)  |
| Unspecified reason                      | 10 (18.87)  |
| The child was sleeping                   | 7 (13.21)   |
| Have you heard of death accidents due to leaving children in locked cars? |
| No                                      | 44 (21.15)  |
| Yes                                     | 164 (78.85) |
| Do you know that children must not be left alone in a locked car even for a couple of minutes? |
| No                                      | 80 (38.28)  |
| Yes                                     | 129 (61.72) |
| How do you expect the temperature inside the locked car to change? |
| Increased                               | 161 (77.40) |
| I do not know                           | 47 (22.60)  |
| Who is more sensitive to heat?           |
| Infants/Children                        | 170 (81.34) |
| Adults                                  | 2 (0.96)    |
| No difference                           | 24 (11.48)  |
| I do not know                           | 13 (6.22)   |
| Do you use a child car seat?            |             |
| No                                      | 117 (56.52) |
| Yes                                     | 90 (43.48)  |
| Are you concerned about females driving and increased incidences of leaving children in cars? |
| No                                      | 94 (44.98)  |
| Yes                                     | 115 (55.02) |

Table 3
Association of baseline characteristics with leaving children inside cars.

| Variable                                | Have you ever left any of your children alone in the car during a sunny day? |
|-----------------------------------------|----------------------------------------------------------------------------|
|                                          | No (n = 157) N (%) | Yes (n = 52) N (%) | P value |
| Age, years (mean ± SD)                  | 35 ± 8.75          | 38 ± 8.16          | .0127   |
| Relationship with child                 |                   |                   | .7055   |
| Mother                                  | 86 (42.79)         | 30 (14.93)         | .0828   |
| Father                                  | 65 (32.34)         | 20 (9.95)          | .0145   |
| Maternal Educational Background         |
| College and Higher                      | 86 (41.9)          | 22 (10.8)          | .0004   |
| High School or less                     | 67 (32.68)         | 30 (14.63)         | .9988   |
| Paternal Educational Background         |
| College and Higher                      | 89 (44.06)         | 20 (9.95)          | .0004   |
| High School or less                     | 62 (30.69)         | 31 (15.35)         | .0004   |
| Number of Children (mean ± SD)          | 3.2 ± 2.2          | 4.8 ± 3.8          | .0004   |
| Monthly Income (mean ± SD)              | 9638.4 ± 6067.2    | 9636.8 ± 5856.6    | .0004   |

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parked car, 12 admitted that they have left their children.

The present study has looked into the association between leaving children inside a locked car and parental age, education, and number of children. We found out that older age, less paternal education, and increased number of children were associated with higher occurrences of children being left in enclosed vehicles in the univariate analyses. To the best of our knowledge, no other studies have investigated this association before.

A survey conducted by Safe Kids Worldwide [14] found out that fathers are three times more likely to leave their children alone in parked cars than mothers, i.e., 23% and 8%, respectively. However, our results show that 14% of mothers compared to 10% of fathers left their children inside locked cars. This result could be attributed to the circumstance that the percentage of female participants was slightly more in our study because most children are accompanied by their mothers to the pediatric clinics.

In Saudi Arabia, women were not allowed to drive until 24 June 2018 [15]. Many women and mothers are undergoing a drastic change. Previously, they have been sitting in the back with the child on their lap or next to their side. Now, they have to focus on navigating through the roads; a new experience for them that can be stressful. We asked the participants in our study about their thoughts toward females driving and concerns of increased incidences of mothers leaving children in the future, and interestingly, almost 55% of participants were concerned about this matter. Hence, we recommend that driving schools for women in Saudi Arabia implement educational strategies (about vehicular heat strokes) for new women drivers upon issuing driving licenses.

The present study showed that parents who used car seats were less likely to leave their children inside locked cars. Inconsistent with this result, Kids and Cars organization [12] have mentioned that there is increased incidence of leaving children in enclosed vehicles with car seat use. Our results could be explained by the fact that parents who use car seats are more concerned with the safety of their children.

Checking the car before closing it has to become an automatic reflex, and to develop this learned behavior, it is important to teach and encourage the need for rituals such as always checking the back of the car even when the driver knows he or she did not bring a child in the car. It is beyond the scope of this article to discuss the pedagogical way in which to integrate this issue in the time-limited driving schools. However, one way is through educating the drivers about the need for ritually checking the car and making it an absolute rule to never leave any child alone in the car for any amount of time, even a minute, as the parent can forget and stay longer at the location (store, etc.) outside of the car.

As several published studies concerning vehicular strokes in children have suggested implementing educational programs and awareness campaigns [2,7,13,16–20], we operated an awareness campaign at King Abdullah Specialist Children’s Hospital in Riyadh. The campaign focused on raising awareness and giving accurate

| Variable                                              | No (n = 157) N (%) | Yes (n = 52) N (%) | P value |
|-------------------------------------------------------|--------------------|--------------------|---------|
| Have you heard of death accidents due to leaving children in locked cars? | 35 (16.83)         | 9 (4.33)           | .4329   |
| Yes                                                   | 121 (58.71)        | 43 (20.67)         |         |
| Do you know that children must not be left alone in a locked car even for a couple of minutes? | 49 (23.4)          | 31 (14.8)          | .0003   |
| No                                                    | 108 (51.7)         | 21 (10.1)          |         |
| How do you expect the temperature inside the locked car to change? | 126 (60.58)        | 35 (16.38)         | .0444   |
| Increased                                             | 30 (14.42)         | 17 (8.17)          |         |
| Do you use a child car seat?                         | 78 (37.7)          | 39 (18.9)          | .0019   |
| No                                                    | 77 (37.2)          | 13 (6.28)          |         |
| Are you concerned about females driving and increased incidences of leaving children in cars? | 80 (38.3)          | 14 (6.7)           | .0025   |
| No                                                    | 77 (36.8)          | 38 (18.2)          |         |

Fig. 1. Percentage of parents leaving their children inside cars who are car seat users. The right bars show parents who use a car seat and the percentage of parents leaving their children inside a car, and the left bars show parents who do not use a car seat and the percentage of parents leaving their children inside a car. This figure shows that there is a lesser incidence of leaving the children inside a locked car among parents who use a car seat.
5. Conclusions

In brief, the present study shows that the prevalence of leaving children unattended inside enclosed vehicles is non-negligible. Universal educational programs and awareness campaigns concerning vehicular heat strokes are encouraged. Integrating such a program in the new driving schools for Saudi women drivers is particularly important due to the change in attention and stress presented on women who will start driving.

Author contributions

Writing - original draft, F.A. and S.A.; Writing - review & editing, O.A., O.D., S.J.; Investigation, F.A. and S.A.; Methodology, F.A., S.A., O.A. and S.J.; Formal analysis, O.D.; Supervision, S.J. All authors edited and approved the final manuscript.

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Declaration of competing interest

The authors declare no conflict of interest.

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