



## Forensic medical evaluation of deaths resulting from inhalation of cigarette lighter refill fuel in Turkey



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### ABSTRACT

Voluntary inhalation/abuse of volatile substances is an important public health problem which especially affects adolescent and young populations worldwide and may be encountered in all socioeconomic and cultural levels. Lighter gas abuse-related death is still an important health problem in Turkey.

In this study, 25,265 case files and final reports submitted to the Institute of Forensic Medicine of the First Specialization Board between January 2011 and December 2015 were evaluated retrospectively. In 56 of these cases, lighter gas inhalation (n-butane, propane, isobutane) was recorded as the cause of death. All subjects were male with a mean age of 16.8 years. According to eyewitness and crime scene investigation reports, in 48 (85.7%) of the cases, a lighter refill container was found at the scene. It was determined that 21.4% of the cases used a plastic bag to increase the effects of lighter gas and 76.8% inhaled the lighter gas via their mouth and nose. The toxicological analysis of the samples taken while hospitalized showed no lighter refill components (n-butane, propane, isobutane) in 66% of the cases, n-butane in 32.1% of the cases, and n-butane + propane + isobutane in 1.9% of the cases.

The importance of lighter gas inhalation-related deaths in Turkey has been increasing. Strict measures against the abuse of these very dangerous substances should be undertaken by the mutual efforts of medical specialists and legislators.

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### 1. Introduction

The abuse of volatile substances is a social problem in many countries. Volatile substances that can be abused include aliphatic, aromatic (glue, gasoline, dyes, adhesives, lacquers, paint removers), and halogenated hydrocarbons (spray paints, nail polish removers, typewriter correction fluids, propellants). There are various methods of abuse. These include direct inhaling from the container (sniffing), inhaling through the nose or mouth from an impregnated rag (huffing), or inhaling from a plastic bag filled with the volatile [1]. Mortality due to the abuse of volatile substances in Turkey has not been investigated, although the most commonly abused volatile substances are known to be paint thinners and adhesives [2]. In the U.K., mortality cases related to the abuse of

volatiles substances are mostly due to inhalation of gaseous fuels, such as butane [3].

Among abused volatile substances, butane is associated with the highest mortality rate [4]. Butane, which is a hydrocarbon, (chemical formula: C<sub>4</sub>H<sub>10</sub>), is a colorless, odorless, lipophilic, liquefied petroleum gas found in lighter fluids, fuels, paint sprays, hair sprays, room odorizers and deodorants. After rapid cooling, it is liquefied and abused in the gaseous state. Lighter fuel, a mixture of butane, propane, and isobutane (75–89% butane and 5–25% isobutane or propane), is cheap and easily attainable, making its abuse relatively easy [5,6].

The causes of death due to the abuse of butane include suffocation, trauma caused by dangerous behavior, vagal inhibition, respiratory depression, and “sudden sniffing death syndrome” following cardiac arrhythmia. Despite this knowledge, the cause of death is seldom clarified during an autopsy [7–10].

The abuse of lighter refill fuel is one of the most important causes of butane-related deaths [6,11,12]. In Turkey, especially in recent years, the abuse of lighter fuels by young people, especially

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adolescents has increased [13–16]. This increase can be attributed to the cheap cost, easy accessibility, and lack of tight countrywide regulatory controls on the supply of lighter fuel the lack of interest shown by related authorities in this growing public health problem [13,14]. Although several case reports have described deaths due to the abuse of lighter refills, no studies have focused on mortality caused by the abuse of butane.

In this study, cases submitted to the First Specialization Board of the Council of Forensic Medicine, Ministry of Justice were reviewed. In Turkey, the First Specialized Board in Turkey acts as a supreme board, with an official specialized commission. Courts countrywide give their final decisions on cases after consulting this governing board. The Board consists of forensic medicine specialists, pathologists, pediatricians, internal medicine specialists, surgeons, neurosurgeons, and gynecologists. This board evaluates all material and files relating to a death, determines the cause, type, and method of death, and then presents its report to the relevant court. The final detailed reports are retained by the Council of Forensic Medicine.

The purpose of this study was to draw attention, with the help of epidemiological data, to the importance of autopsy and incident scene reports in the detection of the causes of death due to the abuse of lighter refill fuel in Turkey. We also present a literature review of the subject.

## 2. Materials and methods

In this study, 25,265 case files and final reports submitted to the Institute of Forensic Medicine of the First Specialization Board between January 2011 and December 2015 were evaluated retrospectively. In 56 of these cases, lighter gas inhalation (n-butane, propane, isobutane) was recorded as the cause of death. These 56 cases were examined, and the following factors were assessed: demographic characteristics, incident scene, findings at the incident scene, macroscopic and histopathological findings in the autopsy, toxicological findings, presence of excessive muscle activity according to witnesses, and the time of the incident.

This study was approved by the ethics committee of the Institution of Forensic Medicine.

### 2.1. Statistical analysis

The nature of the study was not applicable for any kind of regular statistical analysis. Therefore, the demographical data were presented as table data by using the mean and standard deviation. In order to show the differences between the subgroups of the study, percentage data were used.

## 3. Results

The evaluation of the 25,265 files identified 56 cases that had died due to the inhalation of lighter refill fuel. All the cases were males, and they were aged between 12 and 40 years (mean  $\pm$  SD,  $16.8 \pm 4.22$  years). In the study, 75% ( $n = 42$ ) of the cases were younger than 18, and 25% ( $n = 14$ ) were 18 years or older. The deaths due to the inhalation of lighter refill occurred mostly in Istanbul ( $n = 14$ , 25%) and Ankara ( $n = 13$ , 23.2%) (Fig. 1). In 25 (44.6%) cases, there was a history of abuse of volatile substances. The most common sites of death were streets ( $n = 15$ , 26.8%), parks ( $n = 11$ , 19.6%), homes ( $n = 8$ , 14.3%), and wasteland ( $n = 7$ , 12.5%) (Table 1). According to eyewitness and crime scene investigation reports, in 48 (85.7%) of the cases, a lighter refill container was found at the scene. In 8 (14.3%) of the cases, there were no reports of lighter refill containers at the scene. In 33 (58.9%) cases, the deceased had been accompanied by peers during the inhalation of the lighter refill fuel. Twenty (35.7%) of the cases were alone

during the inhalation of the refill fuel. Reports of 3 (5.4 %) of the cases failed to mention whether the deceased was alone or accompanied (Table 1). Regarding the eyewitness and crime scene investigation reports, 15 (26.8%) of the cases had shown extreme physical activity (running, screaming etc.), 27 (48.2%) had not shown any extreme physical activity, and 14 (25%) of the reports did not mention this issue. In 21.4% ( $n = 12$ ) of cases, the deceased had used a plastic bag (bagging) to increase the effects of the lighter gas, and 76.8% ( $n = 43$ ) of cases had inhaled the gas via the mouth and nose (sniffing and snorting). Only one case had used a sweatshirt (huffing) (Table 2).

During the autopsies, the internal and external examinations did not reveal any findings related to trauma in any of the cases. In five cases, the trachea, bronchi, and bronchioles were examined for signs of aspiration. In all cases, the external investigation and macroscopic appearance of the visceral organs displayed only non-specific findings. In the histopathological examination of the heart, nonspecific findings ( $n = 43$ ), perivascular interstitial fibrosis ( $n = 8$ ), myocarditis ( $n = 1$ ), and early-stage myocardial infarcts ( $n = 4$ ) were detected. In the lungs, findings of nonspecific asphyxia (intra-alveolar hemorrhage and edema) ( $n = 50$ ), pneumonia due to long hospitalization ( $n = 4$ ), and findings indicative of intra-alveolar aspiration ( $n = 2$ ) were recorded (Table 3). All but three of the cases were hospitalized for extended periods prior to death, and samples were obtained for toxicological analyses. The toxicological analysis of the samples taken while hospitalized showed no lighter refill components (n-butane, propane, isobutane) in 66% of the cases, n-butane in 32.1% of the cases, and n-butane + propane + isobutane in 1.9% of the cases (Table 4). In all the aforementioned cases, butane was detected in the blood, lungs, and kidney and liver in 100%, 55.6%, and 61.1% of cases, respectively.

## 4. Discussion

Deaths due to the abuse of volatile substances are generally reported in adolescents and young adults [17]. In Turkey, the rate of at least one-time use of any volatile substance during the whole lifetime was reported to be 8.8% [18]. A study conducted in Australia reported that 27.3% of students between the ages of 12 and 17 years had used a volatile substance, at least once [19]. According to the *Monitoring the Future's* 2007 national survey results, in the U.S., 15.7% of 8th-grade students had used a volatile substance, and 26% of the students of the same grade had used a volatile substance in the previous month [20]. However, according to a 2007 study by the National Survey on Drug Use and Health, only 12% of 8th-grade students had used volatile substances [21].

Studies by Esmail et al. and Bowen et al. of volatile substance abuse by older subjects found lower rates of abuse, although the authors stated that they were still disturbingly high [11,12]. Esmail et al. [11] reported that the death rates peaked between the ages of 15 and 16 years. In the study by Bowen et al. [12] the subjects were aged 12–42 years, and 70% were younger than 22 years. According to one study, adult drug users who could not access the drugs that they routinely used turned to volatile substances as an alternative [22]. In the present study, similar to the literature, the average age of the subjects was 16.8 years, 75% were younger than 18 years, and 25% were aged 18 years or older. Individuals who start to abuse volatile substances at a young age may become chronic users, and their level of addiction may be more serious than that of individuals who begin to abuse volatile substances at an older age. Additionally, among users who start to use volatile substances at a young age, the mortality rate with first use is relatively higher [23,24]. The findings of the present study are in line with those in the literature.

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