

COMMUNICATION
UDC 614.878:668.39:794.78**BIOMARKERS OF
EXPOSURE TO
ORGANIC SOLVENTS
FROM GLUES USED IN
TABLE TENNIS BATS**VIŠNJA KARAČIĆ¹, LJILJANA
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In nine samples of the glues used to glue rubber onto the table tennis bats, benzene, toluene, xylene, trichloroethene (TRI) and tetrachloroethene (TETRA) were determined by head-space gas chromatography. The analyses demonstrated the presence of benzene (1.8–4.8% (w/w)), toluene (0.32–33.90% (w/w)) and TRI (0.0006–0.280% (w/w)) in seven samples and of toluene only (22.50–67.20% (w/w)) in two samples. Xylene and TETRA were not detected in any of the glue samples analysed. Benzene, toluene and TRI in blood, as a measure of body burden, were determined in four table tennis players (aged 11–14 years) and five volunteers (aged 26–38 years). They were at the same level as in the general population. The aim of the study was to draw attention to the possibility of exposure to organic solvents from glues used in table tennis bats, particularly as it is very often a question of child exposure.

Key terms:
biological markers, general population exposure, organic solvents toxicity

In modern society organic solvents are used in an extremely wide range of applications. The toxicity of organic solvents has been known for many years and even when a low toxicity solvent is used exposure should be kept as low as possible. While, traditionally, attention was paid to occupational exposure to organic solvents, recently several studies have linked various activities with increased exposure to certain organic solvents in the general population (1–3). The conditions under which organic solvents are used in the general population are very often unknown and the consumers may be at risk.

In this study, the activity selected was table tennis, since it has become customary to reglue the rubber of the table tennis bat before each game, allegedly on account of "the speed glue effect". Five selected organic solvents, benzene, toluene, xylene, trichloroethene (TRI) and tetrachloroethene (TETRA), were

analysed in the glues used in table tennis bats. The reason for the selection of the above solvents lies in their known toxic effects: benzene has been described as leukemogen (4) and carcinogen (5, 6) to humans, toluene and xylene primarily affect the central nervous system (7, 8), TRI could be hepatotoxic (9) and TETRA is an established animal carcinogen (10).

This study was designated with the aim to assess tennis players' exposure to selected organic solvents from glues, and to reveal a possible influence on body burden by use of biological monitoring, the best means of estimating the amount of a chemical absorbed into the body of an individual.

MATERIALS, SUBJECTS AND METHODS

Benzene, toluene, xylene, TRI and TETRA were analysed in nine samples of glues, from different manufacturers in Europe, used for glueing the rubber onto the table tennis bat. Seven samples of glues were in original cans or tubes and two were in little glass containers decanted from large cans. All glues were marked with numbers from 1 to 9. Organic solvents in the glues were determined qualitatively and quantitatively by head-space gas chromatography using a flame ionization detector for aromatic hydrocarbons and an electron capture detector for halogenated hydrocarbons (3, 11). The concentrations of analytes in the glues were expressed as percentages (w/w) (weight/weight).

The subjects in the study were four table tennis players, 11-14 years old, who glued rubber onto table tennis bats before each game, and five volunteers, 26-38 years old, who simulated the glueing of rubber onto the table tennis bats, 10 minutes daily for three weeks.

The table tennis players and volunteers used the same glues, marked 3, 6 and 8. All subjects were non-smokers, and were not exposed to any other solvents.

Samples of venous blood were taken from each subject into glass vials containing heparin, about 16-18 h after exposure to glues, and were analysed on the same day. The analytes in blood were analysed by head-space gas chromatography according to the methods of *Angerer and co-workers* (12) and *Kežić and co-workers* (13). The detection limit (DL) was 0.90 µg/L for benzene, 1.24 µg/L for toluene, 2.20 µg/L for xylene, 0.015 µg/L for TRI and 0.010 µg/L for TETRA. The results for all analytes in blood were checked regularly, as the laboratory participates in the Interlaboratory Comparison Programme, organized by the German Society of Occupational and Environmental Health in Erlangen. The results for all analytes in blood are presented as ranges.

RESULTS AND DISCUSSION

Table 1 shows the concentrations of benzene, toluene and TRI in nine samples of glues used in table tennis bats. The analyses of glues demonstrated the presence of benzene (1.8-4.8% (w/w)), toluene (0.32-33.90% (w/w)) and TRI (0.0006-0.280% (w/w)) in seven samples, and of toluene only (22.50-67.20% (w/w)) in two samples (nos 2 and 7). It could be that these two samples of glues were diluted with toluene as they were not in the original package. Xylene and TETRA were not detected in any of the glues. Table 2 shows the concentration of benzene, toluene and TRI in blood, as a measure of the body burden in four table tennis players and five volunteers. The benzene and toluene blood concentrations were below the detection limit (for both benzene and toluene) i.e. as in the general population (14). TRI ranged from 0.017 to 0.040 µg/L for table tennis players, and from 0.020-0.045 µg/L for volunteers, also as in the general population (15).

Table 1 Concentrations of selected organic solvents: benzene, toluene, xylene, trichloroethene (TRI) and tetrachloroethene (TETRA) in glues used in table tennis bats

No. of samples	Benzene % (w/w)	Toluene % (w/w)	Xylene % (w/w)	TRI % (w/w)	TETRA % (w/w)
1	4.6	nd	nd	0.003	nd
2	nd	67.20	nd	nd	nd
3*	3.3	33.10	nd	nd	nd
4	nd	33.90	nd	0.003	nd
5	1.8	5.40	nd	0.280	nd
6*	4.8	0.46	nd	0.003	nd
7	nd	22.50	nd	nd	nd
8*	1.9	14.60	nd	0.003	nd
9	nd	0.32	nd	0.0006	nd

nd - not detected
 * - used in examined groups

Table 2 Range values of exposure biomarkers: benzene, toluene and trichloroethene (TRI) in the blood of tennis players and volunteers

Examined subjects	Benzene µg/L	Toluene µg/L	TRI mg/L
Players (n=4)	<0.90 i.e. <DL	1.24 i.e. <DL	0.017-0.040
Volunteers (n=5)	<0.90 i.e. <DL	<1.24 i.e. <DL	0.020-0.045

DL - detection limit

In spite of the surprisingly high percentage of benzene and toluene in some glues used in this study, it was not possible to detect them in the blood of examined subjects. The reason for this could be relatively low sensitivity due to the equipment used i.e. a flame ionization detector instead of a more sensitive photoionization detector (16). The number of examined subjects was also too small, although this was only a preliminary study.

However, the results of this study indicate a new source of exposure to organic solvents in the general population. The fact that table tennis players are very often young should attract the attention of sports committees, which have the jurisdiction to ban the use of glues in certain sports. It should be emphasized that this is the first such study in this country.

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Sažetak

IZLOŽENOST ORGANSKIM OTAPALIMA IZ LJEPILA U REKETIMA ZA STOLNI TENIS

Opisan je dosada nepoznati izvor izloženosti organskim otapalima u općoj populaciji. Naime, u stolnom tenisu uobičajeno je lijepljenje gume na drveni dio reketa, neposredno prije nastupa, kako bi se povećala brzina odbijanja loptice. U devet ljepila različitih proizvođača iz Europe, analizirana su toksična organska otapala, za koja se, iz literature i iz vlastitih dosadašnjih istraživanja, zna, da mogu biti sadržani u ljepilima: benzen, toluen, ksilen, trikloreten (TRI) i tetrakloreten (TETRA). Ljepila su analizirana plinsko-kromatografskom tehnikom, analizom pare iznad uzorka. U ljepilima je dokazan benzen (1,9-4,8% težinski), toluen (0,32-33,90% težinski) i TRI (0,0006-0,280% težinski) u sedam uzoraka, dok je u dva uzorka dokazan samo toluen (22,50 i 67,20% težinski). Ksilen i TETRA nisu dokazani niti u jednom uzorku. Da bi se utvrdio eventualni unos otapala u organizam, analizirani su benzen, toluen i TRI u krvi četiriju igrača stolnog tenisa (11-14 god.) te pet dobrovoljaca (26-38 god.). U svih ispitanika mjereni pokazatelji u krvi bili su unutar vrijednosti nađenih u općoj populaciji. I pored činjenice da provedenim ispitivanjem nije utvrđeno opterećenje tijela otapalima iz ljepila korištenih u stolnom tenisu, dobiveni rezultati upućuju na oprez uz eventualnu zabranu korištenja tih ljepila u sportu, u kojem su najčešće izložena školska djeca.

Ključne riječi:

biomarkeri, izloženost opće populacije, toksičnost organskih otapala

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