Arh. hig. rada, *21* (1970) 315.

PHYSICAL STRENGTH AND SKILFULNESS OF SMALL CHILDREN IN OPENING DRUG AND CHEMICAL CONTAINERS

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(Received for publication November, 6, 1970)

The closures of drug and chemical vials are safe from misuse by children if the locking power of seals has to exceed the manual traction and torsion power of a child's hand and if the sealing device has to provide for trigger-points in distances large enough to exceed the spread of a child's hands. The authors have conducted tests in 242 children to establish their manual traction and torsion power. The results are given in tables. The maximal traction and holding power of children 2–5 years old on knob or disc-shaped handles of 4–30 mm diameter were 1–3,5 Kp and approximate maximum of the angular momentum on handles between 2–68 mm were 20–100 mp.

The safety closures of drug and chemical vials in use to-day are not satisfactory as yet from a practical point of view.

Their construction is based essentially on the principle to exceed the manual skill of small children by means of combined pressure, traction and torsion movements necessary for opening (2, 3, 4). This is basically correct. Accordingly to our tests, however, such devices were opened frequently by children as young as 2–3 years of age. This was accomplished by ripping with the teeth, by shearing the caps off at a table edge and, if need be, by breaking the container. Technical refinements of such devices may sham safety for the adult action according to habit and convention. The child is not burdened by such rules; he overcomes difficulties inventively and unconventionally.

Vials and seals of drugs and chemicals are safe to some extent from misuse by children if two physiological differences of size between the adult and the pre-school child are taken advantage of:

1) the locking power of seals has to exceed the manual traction and torsion power of a child's hand.

2) the sealing device has to provide for trigger-points in distances large enough to exceed the spread of a child's hand (Fig. 1) (1, 3).

A third possibility is to choose an unlocking mechanism, the use of which is not easily understood by smal children.

Tests of the manual pressure power of children's hands have been documented several times before. However, we have not, as yet, found data on manual traction and torsion power in children. We therefore conducted tests of this kind in 242 children (119 males and 123 females). We used gauged spring balances with handles of different sizes (4–30 mm), and turning spring balances with turning handles of diamcters between 20 and appr. 68 mm.

The maximal traction and holding power of hands of children 2–5 years old on knob or disc-shaped handles of 4–30 mm diameter were 1–3,5 kp (Table 1), according to our investigations (2).

Table 1

Maximal manual traction-powers of preschool-children (approximative)

Age	Diameter of tractive-objects			
	4 mm	7 mm	13 mm	30 mm
2 years	1 kp	1,5 kp	2 kp	2 kp
3 years	1,5 kp	2,5 kp	3 kp	3 kp
4 years	2 kp	2,5 kp	3 kp	3,5 kp
5 years	2 kp	2,5 kp	3,5 kp	3,5 kp

The approximate maxima of the angular momentum produced manually by these children on handles between 20–68 mm were from 20 mp to 100 mp (Table 2) (2).

Table 2

Maximal manual torque-power (angular momentum) of preschool-children (approximative)

Age	Diameter of torque-objects			
	20 mm	30 mm	47,5–48 mm	67,5 mm
2 years	20 mp	30 mp	40 mp	50 mp
3 years	40 mp	60 mp	90 mp	100 mp
4 years	40 mp	70 mp	90 mp	100 mp
5 years	40 mp	70 mp	100 mp	100 mp

Such differences in effort correspond to differences of maximal hand-spread between the tips of the thumb and 5th finger. There were significant differences between the 2 years and the 3–5 years old groups as to maximal spread, as well as to manual traction and torsion power. In contrast, similar values were distributed around the same mean in the 3–5 years old group. In comparison to the powers measured for children's hands we studied, moreover, the forces necessary to open the conventional locking devices of drug and chemical containers (Figs. 2, 3). As shown in Table 3 the required tractive powers and resistances to the angular momentum of the devices available commercialy are below the range of ability of 4–5 years old children. Even in the 3 years old ones maximal efficiencies exceed the locking power of many seals. They do not, therefore, present a sufficient obstacle to small children.

Yet we noted to our surprise that small children had unexpectedly big difficulties in opening the little resistant foil packings. Apparently small children did not easily understand the opening mechanism, which is breaking the bottom foil in order to take a single tablet. They mostly tried to tear the foil with the fingers which was difficult because the material was slippery and elastic.

Even if they were successful the children had access to only one tablet at a time, and not to the contents of a whole package as in bottles and boxes. Only for closures of drug and chemical cabinets it makes sense to profit of the smaller hand-spread of pre-school children. According to our tests, a three-point unlocking system with more than 16 cm distance of its pressure or torsion points prevents the access of children below 5 years, extreme exceptions excluded (Fig. 1).

An efficient locking-mechanism combining movement with the use of everyday tools is available in the double-cap safety lock shown in Fig. 4.* The principle of this device is a coupling of two concentric turning caps by means of a coin or flat piece of wood, a nail or a match. Only by coupling the outer turning cap with the inner cap, the cap can be screwed-off from the thread of the vial. We tested these caps as well in 100 children between ages 2 and 5 years. Although the opening force necessary (30 mp) was well within the ability of the children, only few of the 4 and 5 years old ones were able to open such caps after extensive prior instruction. Special difficulties were encountered with the cap which had the slot on one side. This was mainly so because the children's hands were unable to keep the coupling tool in contact with the slot of the cap while turning it.

CONCLUSION

The safety locking-mechanisms available in trade hitherto do not offer sufficient difficulties to small children. New ways and methods must be found.

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Table 3

Manual efforts necessary to open locking devices of drugs and chemicals

Type of locking device: Size of locking device:	Forces necessary		
	traction	pressure	angular momentum
»Palm-N-Turn«			
27 mm ⌀	———	3,5–5 kp	incon-
40 mm ⌀	———	3,5–5 kp	siderable
»Safety Cap« (»U-press-it«)			incon-
30 mm ⌀	———	3,5–4 kp	siderable
Secured turning cap of acetic acid bottle	2,5–3,5 kp	———	incon-
19 mm ⌀	———	———	siderable
Safety cap with top or lateral slot-coupling			20 mp
33 mm ⌀	———	———	or less
Turning cap lock			
Bakelite:			
23 mm ⌀	———	———	30 mp
50 mm ⌀	———	———	35 mp
Metal:			
opened before:			
23 mm ⌀	———	———	20 mp
27 mm ⌀	———	———	20 mp
31 mm ⌀	———	———	35 mp
not opened before:			
23 mm ⌀	———	———	25 mp
27 mm ⌀	———	———	35 mp
31 mm ⌀	———	———	45 mp
Turning stopper lock			
22 mm ⌀	1,5–2,5 kp	———	10 mp
28 mm ⌀	2 –3 kp	———	35 mp
Cap			
20 mm ⌀	1,0–1,5 kp	———	———
Shift-lock	bis 0,5 kp	———	———
Cover-lock	2,0–2,5 kp	———	———

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Sažetak

O RUČNOJ SNAZI I SPRETNOSTI MALE DJECE U OTVARANJU POSUDA S LIJEKOVIMA I KEMIKALIJAMA

Zapori na bocama, bočicama, cjevčicama i drugim posudama i posudicama koje sadrže lijekove i kemikalije sigurni su od dječje zloupotrebe i otvaranja samo onda ako je za njihovo otvaranje potrebna jača snaga u dječjim rukama nego što je snaga kojom se ti zapori zatvaraju odnosno, ako je zaporna naprava tako usklađena da su otponske točke udaljenije nego što iznosi udaljenost maksimalno raširenih prstiju dječje ruke. Autori su podvrgli testiranju 242 djece da utvrde vlak njihovih ruku i snagu zakretanja. Rezultati su prikazani u tablicama. Najveći vlak i snaga djece od 2 do 5 godina na okrugli zaporac ili zaporac u obliku diska promjera 4–30 mm bila je 1–3,5 Kp, a prosječni maksimum kutnog zakretanja zaporaca između 2–68 mm bio je 20–100 mp.

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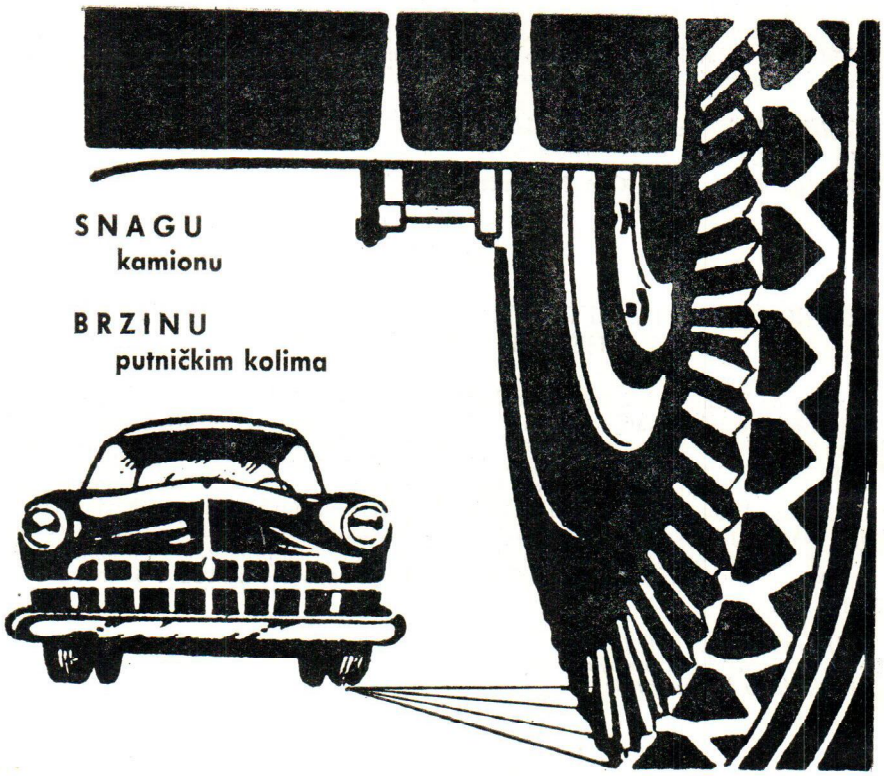
Primljeno 6. XI 1970.



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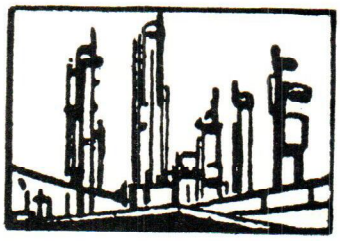

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