

Injuries in public and private playgrounds: the relative contribution of structural, equipment and human factors

E Petridou^{1,2}, J Sibert³, X Dedoukou¹, I Skalkidis¹ and D Trichopoulos^{1,2}

Department of Hygiene and Epidemiology¹, Athens University Medical School, Athens, Greece; Department of Epidemiology², Harvard School of Public Health, Boston, Massachusetts, USA; Department of Child Health³, University of Wales, College of Medicine, Penarth, UK

Petridou E, Sibert J, Dedoukou X, Skalkidis I, Trichopoulos D. Injuries in public and private playgrounds: the relative contribution of structural, equipment and human factors. *Acta Pædiatr* 2002; 91: 691–697. Stockholm. ISSN 0803-5253

The aim of this case-control study was to identify and quantify risk factors of injuries in playgrounds, where children spend an increasing amount of time in developed countries. The study took place in Greater Athens during 1999. A continuous Emergency Departments Injury Surveillance System (EDISS) of hospitals that cover about 30% of the children's time at risk in Greater Athens identified 777 injuries in public and private playgrounds out of a total of 17 497 injuries. Public playgrounds differ from private ones, because the former generally have more equipment, usually of greater height, with less resilient surfaces, and supervision relies mainly on parents or guardians. Patterns of type of playground use were assessed in a sample of 294 children from the same study base who served as a control group in a hierarchical case-control design. The annual incidence of playground injuries in Greater Athens was about 7 in 1000 among boys and 4 in 1000 among girls, with a 2.2 times higher risk for an injury in public than in private playgrounds (95% confidence interval 1.61–3.07). Children in public vs private playgrounds had a statistically significant eight times higher odds for concussion and six times higher for open wounds, whereas the odds for long bone fractures were four and for other fractures two; swings, slides and seesaws were the types of equipment most frequently associated with injuries. It was further shown that supervision of children was suboptimal (<60%) in both public and private playgrounds, and children in private playgrounds sustained an unduly high frequency of sprain/dislocation injuries (odds ratio 1.75) because they were encouraged to play bare-footed.

Conclusion: Close to 50% of playground injuries could be prevented by structural and equipment changes, while further reduction could be accomplished through simple measures including closer supervision and encouraging children to wear proper shoes and use protective equipment whenever necessary.

Key words: *Case control, childhood injury, playground equipment, public versus private playground*

E Petridou, Athens University Medical School, 75 M. Asias Str., GR-11527, Athens, Greece (Tel. + 301 7462 111, fax. + 301 7773 840, e-mail. epetrid@med.uoa.gr)

Injuries represent the leading cause of mortality and a source of substantial morbidity in children throughout the world (1, 2). A sizeable and increasing fraction of children's activities, mainly of those living in urban centres, takes place in playgrounds that were introduced to provide a controlled, protected and supervised environment in which children could socialize and develop their skills. Playgrounds are generally safer than neighbourhood streets, but leisure time spent in them is not risk free. The dilemma is how to keep playgrounds attractive to youngsters and conducive to the development of their physical skills through physical activity, without compromising safety. Rational policies for playground use, aiming to minimize injury risk without creating an environment that is unappealing to children, require quantitative informa-

tion on injuries as well on the relationship of injuries to exposure time and quality of equipment and ground surfaces.

A study was undertaken in the Greater Athens area comparing accident and injury patterns in public and private playgrounds. In Greece, public playgrounds are those for which no payment is required and include those belonging to the local councils, schools, public day care centres and holiday camps. Public playgrounds have minimal staff and children's supervision relies on parents or guardians. They also have an abundance of equipment which, however, is generally poorly maintained, as shown in a recent survey of playgrounds in both rural and urban regions of Greece. In contrast, playgrounds are considered as private when payment is required or when the parents use the products or

Table 1. Distribution of 777 children with playground injuries recorded in EDISS during 1999 and the corresponding distribution of 294 children without a playground injury from the same study base by age, gender, nationality and type of playground (public or private). In the lower panel, multiple logistic regression derived odds ratios (OR) and 95% confidence intervals (95% CI) are shown.

Variable	Playground:	Injured children		Non-injured children	
		Public	Private	Public	Private
Age (y)					
<5		244 (37.5)	42 (33.3)	81 (39.5)	31 (34.8)
5–9		315 (48.4)	74 (58.7)	78 (38.0)	45 (50.6)
10–14		92 (14.1)	10 (8.0)	46 (22.4)	13 (14.6)
Gender					
Male		419 (64.4)	67 (53.2)	118 (57.6)	49 (55.1)
Female		232 (35.6)	59 (46.8)	87 (42.4)	40 (44.9)
Nationality					
Greek		560 (86.0)	125 (99.2)	191 (93.2)	88 (98.1)
Migrant		91 (14.0)	1 (0.8)	14 (6.8)	1 (1.1)
Total		651	126	205	89
	OR	95% CI	<i>p</i>		
Public vs private	2.22	1.61–3.07	0.0001		
Age: <5 vs 5–9 y	0.78	0.57–1.06	0.10		
Age: ≥10 vs 5–9 y	0.50	0.34–0.73	0.0004		
Males vs females	1.27	0.95–1.67	0.10		
Migrant vs Greek	2.00	1.13–3.54	0.02		

Data are *n* (%)

EDISS: Emergency Departments Injury Surveillance System.

services of the establishment to which the playground belongs. They are frequently indoor establishments that, as a rule, are attached to fast-food restaurants, supermarkets or coffee shops. The philosophy underlying private playgrounds is to maximize safety through supervision and avoidance of structures or equipment that may create an injury risk. The contrast between public and private playgrounds in Greece allows for an estimation of how many injuries could be prevented by an optimal environment.

Methods

During 1999, 777 playground injuries among children (0–14 y) residing in the Greater Athens area were recorded in the Emergency Department Injury Surveillance System (EDISS) run by the Center for Research and Prevention of Injuries among the Young (CEREPI). According to the operational definition used in this study all injuries that occurred in a public or private establishment providing playground facilities were included, whereas 81 injuries that were caused by playground equipment located in households or amusement parks were excluded from the data set. More specifically, the rubrics used to retrieve the data set were: 81 and 83 for place of occurrence and 42 210–42 499 for object causing or involved in the injury of the European Home and Leisure Accidents Surveillance System (EHLASS) 1986 coding manual (3), as well as rubrics E 8840 of ICD-9 and W09 of ICD-10 of the

World Health Organization (WHO) coding manuals, describing the mechanism of injury (4, 5). Subsequently, each entry was compared for consistency with the free text description of each event. In the Greater Athens area EDISS relies on data collected at the accident and emergency departments of two hospitals, one of which is a trauma hospital and the second is one of the two children's teaching hospitals in the area, which cover about 30% of the childhood population. Specially trained health visitors interview the child's guardian in person, using a precoded questionnaire. This aims to elicit information on sociodemographic characteristics, the mechanism and the objects most directly involved in the injury (e.g. type of playground equipment), type of injury and body part injured, supervision patterns, medical evaluation of the injured child and type of treatment. All information is recorded and coded in a computerized database. Incidence rates for playground injuries in the Greater Athens area can be estimated from this database using appropriate sampling fractions (6).

In general, private playgrounds have fewer types of equipment with more resilient surfaces, and are more likely to adhere to international standards. Therefore, it was deemed important to calculate the relative frequency of an injury separately in each of the two types of playground. This calculation requires the number of children injured in public and private playgrounds during a specified period in relation to the total childhood population in the respective study base. Moreover, an estimate of the relative frequency and

Table 2. Multiple logistic regression derived odds ratios (OR) and 95% confidence intervals (95% CI) for an injury in public vs private playgrounds by type of injury controlling for age, gender and nationality.

Type of injury	No. public	No. private	OR	95% CI	p
Concussion	38	2	7.98	1.87–34.16	0.005
Open wound	221	14	6.47	3.53–11.87	< 0.001
Long bone fractures	96	9	4.27	2.01–9.09	< 0.001
Other fractures	59	11	2.37	1.17–4.80	0.02
Sprain/dislocation	39	32	0.57	0.33–0.99	0.05

duration of use of public and private playgrounds by children is needed. This information was collected by an independent survey of 336 children from the same study base, with minor ailments, who attended the emergency non-injury departments of the same hospitals that provide data for EDISS. The guardians of these children were interviewed in person by the same health visitor during a 3 mo period (September to November) on a basis of a short precoded questionnaire, providing information on the type of playground (public or private) that their child had last used during the preceding year and the frequency of attendance. Out of these children, 42 were excluded because they did not report playground attendance during the preceding year. The average duration of stay in the playground was indicated, as well as basic demographic characteristics (age, gender and nationality). The average duration of stay was similar in the public and private playgrounds. Therefore, the odds ratio (OR) from the case-control

Table 3. Distribution of the 777 childhood accidents in playgrounds of the Greater Athens area recorded in EDISS for 1999 by object causing the injury and type of playground.

Object that caused the injury	Playground	
	Public	Private
Playground equipment		
Swing	72 (11.1)	0 (0.0)
Seesaw	6 (0.9)	0 (0.0)
Climbing frame	8 (1.2)	1 (0.8)
Slide	34 (5.2)	6 (4.8)
Other equipment	12 (1.8)	7 (5.6)
Surface		
Asphalt, cement	80 (12.3)	2 (1.6)
Gravel	117 (18.0)	1 (0.8)
Earthen surface	170 (26.1)	3 (2.4)
Wall-to-wall carpet	4 (0.6)	18 (14.3)
Plastic synthetic surface	3 (0.5)	13 (10.3)
Mat	1 (0.2)	29 (23.0)
Other ground	21 (3.2)	0 (0.0)
Stone (on the ground or thrown)	44 (6.8)	0 (0.0)
Stairs	5 (0.8)	0 (0.0)
Human	10 (1.5)	11 (8.7)
Football	8 (1.2)	1 (0.8)
Toys	0 (0.0)	11 (8.7)
Other	56 (8.6)	23 (18.3)
Total	651 (100.0)	126 (100.0)

Data are n (%).

EDISS: Emergency Departments Injury Surveillance System.

analysis (in which cases are the injured children in playgrounds and controls the non-injured, and exposure is attendance of a public or private playground) is believed to be an unbiased estimate of the incidence rate ratio of injuries between the two types of establishment (7).

The initial analysis was performed using cross-tabulations. The OR for an injury in a public rather than a private playground, with simultaneous adjust-

Table 4. Distribution of the 777 children with playground injuries in the Greater Athens area recorded in EDISS for 1999 by accident and injury descriptive variables, and type of playground.

Variable	Type of playground		p
	Public	Private	
Time of accident			0.16
09.00–12.59	129 (19.8)	17 (13.5)	
13.00–16.59	139 (21.4)	22 (17.5)	
17.00–20.59	300 (46.1)	66 (52.4)	
21.00–24.00	83 (12.7)	21 (16.6)	
Day of accident			0.001
Weekday	423 (65.0)	39 (31.0)	
Weekend	228 (35.0)	87 (69.0)	
Season of accident			0.001
Winter–autumn	254 (39.0)	83 (65.9)	
Summer–spring	397 (61.0)	43 (34.1)	
Mechanism of accident			0.001
Fall from height	360 (58.4)	46 (36.5)	
Fall on the same level	85 (13.0)	33 (26.2)	
Struck, hit, by object	122 (18.7)	13 (10.3)	
Overexertion	27 (4.2)	29 (23.0)	
Other	37 (5.7)	5 (4.0)	
Injured body part			0.001
Head	334 (51.3)	34 (27.0)	
Upper limbs	194 (29.8)	37 (29.4)	
Lower limbs	90 (13.8)	49 (38.9)	
Trunk	33 (5.1)	6 (4.7)	
Number of injuries			0.001
One	531 (81.6)	119 (94.4)	
Multiple	120 (18.4)	7 (5.6)	
Injury Severity Score			0.005
< 2	435 (66.8)	100 (79.4)	
≥ 2	216 (33.2)	26 (20.6)	
Outcome			0.001
Examined	107 (16.5)	30 (23.8)	
Treated	140 (21.5)	54 (42.9)	
Treated and followed up	342 (52.5)	37 (29.3)	
Admitted	62 (9.5)	5 (4.0)	

Data are n (%).

EDISS: Emergency Departments Injury Surveillance System.

Table 5. Multiple logistic regression-derived odd ratios (OR) and 95% confidence intervals (95% CI) for an accident in a public rather than private playground by a series of accident and injury variables, controlling for age, gender and nationality.

Variable	Category or increment	OR	95% CI	<i>p</i>
Time of accident	09.00–12.59	Baseline		
	13.00–16.59	1.14	0.54–2.43	0.72
	17.00–20.59	0.81	0.43–1.54	0.53
	21.00–24.00	0.51	0.23–1.12	0.09
Day of accident	Weekday	3.39	2.14–5.38	0.0001
	Weekend	Baseline		
Season of accident	Winter—autumn	Baseline		
	Summer—spring	2.01	1.28–3.17	0.002
Mechanism of accident	Fall from height	Baseline		
	Fall on the same level	0.32	0.19–0.56	0.0001
	Struck, hit, by object	0.97	0.48–1.93	0.92
	Overexertion	0.13	0.07–0.26	0.0001
	Other	0.76	0.27–2.14	0.60
Additional, alternatively introduced variables				
No. of injuries	One	Baseline		
	Multiple	2.91	1.25–6.81	0.01
Injured body part	Head	1.68	0.61–4.65	0.31
	Upper limbs	1.01	0.36–2.80	0.98
	Lower limbs	0.56	0.20–1.57	0.26
	Trunk	Baseline		
Injury Severity Score	<2	Baseline		
	≥2	1.67	0.99–2.82	0.05
Outcome	Examined	Baseline		
	Treated	1.03	0.56–1.90	0.92
	Treated and followed up	2.88	1.59–5.22	0.0005
	Hospitalized	2.51	0.84–7.47	0.09

ment for demographic factors, was calculated through multiple logistic regression. The risk profile of injuries in the two types of establishment (conditions of accident and nature of injuries) was ascertained through both multiple logistic regression (8) and cluster analysis (9). The SAS statistical software was used.

Results

From the surveillance system, 777 children who sustained a playground injury in 1999 were recorded. Table 1 shows the distribution of 294 children with no injuries who were recruited from the ad hoc survey and of the 777 children who had sustained a playground injury and that was recorded in EDISS by type of establishment, age, gender and nationality. On the basis of these data ORs contrasting public with private playground establishment, boys with girls, migrants with Greek nationals and three age groups were calculated. The risk of injury was 2.2 times higher in public than in private playgrounds and the excess risk was statistically significant. Children of migrants had a significant doubling of risk for a playground injury compared with children of Greek nationals. There was also evidence that boys were at increased risk compared with girls, with a borderline significance of $p = 0.10$, and that the highest risk of injury concerned children aged 5–9 y. To the extent that public playgrounds differ from private ones mostly in terms of equipment, it

appears that 55% [(2.2–1)/2.2] of all injuries in public playgrounds, that is 358 injuries, could be attributed to equipment or structural differences between the two types of establishment. These 358 injuries represent 46% (358/777) of all playground injuries and may be thought of as the fraction of playground injuries that could be prevented if public playgrounds were structured and equipped similarly to the private ones.

The study further explored whether the type of playground (private or public) selectively affects the nature of injuries, controlling for gender, age and nationality. Table 2 shows the ORs for specific injuries in public vs private playgrounds. In public playgrounds the incidence of concussion was 8 times higher ($p = 0.005$), open wounds 6.5 times higher ($p < 0.001$), long bone fractures 4.3 times higher ($p < 0.001$) and other fractures (elbow fractures in 25 out of 70 instances) 2.4 higher than in private playgrounds ($p = 0.02$). In contrast, the incidence of sprain and dislocation was significantly higher in private playgrounds (OR = 0.6, $p = 0.05$). The more serious consequences in public playgrounds appear to reflect the greater height of equipment, harder ground surface and poor maintenance (e.g. unsmoothed edges) encountered in many public playgrounds compared with most private ones.

The distribution of injuries by type of playground and the object most directly involved in the accident is shown in Table 3. This table demonstrates the equipment and objects that generate higher injury risks in

Table 6. Distribution of the 777 childhood accidents in playgrounds of the Greater Athens area recorded in EDISS for 1999 by demographic, accident and injury descriptive variables in three clusters derived from hierarchical cluster analysis.

Variable	Cluster		
	1st	2nd	3rd
Age (y)			
<5	23 (8.1)	188 (65.7)	75 (26.2)
5-9	93 (23.9)	111 (28.5)	185 (47.6)
≥10	26 (25.5)	32 (31.4)	44 (43.1)
Gender			
Male	103 (21.2)	223 (45.9)	160 (32.9)
Female	39 (13.4)	108 (37.1)	144 (49.5)
Nationality			
Greek	117 (17.1)	281 (41.0)	287 (41.9)
Migrant	25 (27.2)	50 (54.3)	17 (18.5)
Type of playground			
Public	133 (20.4)	309 (44.5)	209 (32.1)
Private	9 (7.1)	22 (17.5)	95 (75.4)
Mechanism of accident			
Fall from height	112 (26.3)	189 (44.4)	125 (29.3)
Fall on the same level	16 (13.5)	46 (39.0)	56 (47.5)
Struck, hit, by object	5 (3.7)	89 (65.9)	41 (30.4)
Overexertion	4 (7.1)	0 (0.0)	52 (92.9)
Other	5 (11.9)	7 (16.7)	30 (71.4)
Type of injury			
Concussion	0 (0.0)	40 (100.0)	0 (0.0)
Contusion abrasion	0 (0.0)	40 (19.9)	161 (80.1)
Open wound	3 (1.3)	214 (91.0)	18 (7.7)
Fracture	133 (76.0)	11 (6.3)	31 (17.7)
Sprain/dislocation	1 (1.4)	4 (5.6)	66 (93.0)
Other	3 (13.1)	9 (39.1)	11 (47.8)
No injury diagnosed	2 (6.3)	13 (40.6)	17 (53.1)
Injured body part			
Head	1 (0.3)	321 (87.2)	46 (12.5)
Upper limbs	140 (60.6)	2 (0.9)	89 (38.5)
Lower limbs	1 (0.7)	8 (5.8)	130 (93.5)
Trunk	0 (0.0)	0 (0.0)	39 (100.0)

Data are *n* (%).

EDISS: Emergency Departments Injury Surveillance System.

public than in private playgrounds (swing, slide, seesaw, climbing frame, hard ground surface, abundance of loose stones).

Table 4 shows the distribution of 777 children with playground injuries by accident and injury descriptive variables and type of establishment. *p*-Values from simple bivariate analysis are also shown. Overall, more than two-thirds of injuries were the consequence of falls; they appear to be more common in the late afternoon and early evening, reflecting Greek family lifestyles in spending their leisure time. In private playgrounds accidents were frequent during weekends. There was an interesting contrast between type of playground and seasonal occurrence of injuries: private playgrounds are generally indoors, whereas most public playgrounds are outdoors. The injury descriptive variables generally reflect the fact that injuries were generally more severe in public playgrounds.

The multiple logistic regression-generated ORs for a specific characteristic in a public rather than a private playground are shown in Table 5. The characteristics investigated with mutual control of confounding variables were: time, day, season and mechanism of accident, age, gender and nationality. Variables concerning severity of injury were alternatively introduced to avoid the consequences of strong collinearity. The ORs in Table 5 clearly reflect proportional contrasts because the injury series in public vs private playgrounds were compared without allowance for person-time at risk, which was reflected in the separate playground attendance survey. It is apparent that most accidents in public playgrounds occurred during weekdays, reflecting the pattern of attendance in this type of playground, mostly by children of working families. During summer and spring, public playgrounds are attended more frequently because children of working families tend to spend more leisure time in the open public playgrounds, whereas the indoor private playgrounds are mostly attended during autumn and winter. After controlling for day and season of accident, the within-day distribution of these accidents was similar between public and private playgrounds, not withstanding a tendency for accidents in private playgrounds to occur during late afternoon and evening hours, when these establishments are frequently attended by children and parents. Finally, evaluation by mechanism of accident demonstrates again that fall from a height specifically characterizes those occurring in public playgrounds. In contrast, overexertion injuries are much more likely to occur in private playgrounds, where children are usually playing barefooted. The alternatively introduced variables reflecting the severity of injury collectively indicate that injuries in public playgrounds are generally more serious than those in private establishments. It is worth noting that children in public playgrounds have almost three times higher odds of sustaining multiple rather than single injuries, 70% higher odds of having an Injury Severity Score of ≥ 2 and a higher hospitalization rate compared with those attending private playgrounds.

Table 6 shows the results of the analysis in three main clusters. The first cluster consists of injuries in public playgrounds among boys, children of migrants, older than 5 y, mostly sustaining fractures of the upper limbs as a consequence of a fall from a height. The second cluster consists of injuries also occurring in public playgrounds among children less than 5 y old, sustaining concussion or open wounds to the head after being hit by a stone or another object and, to a lesser extent, a fall from a height. The third cluster consists of injuries in private playgrounds, mainly among girls of Greek nationality aged mostly 5-9 y, sustaining sprain and dislocation and other mild injuries in the lower limbs and trunk subsequent to overexertion or a fall from the same level. These results are compatible with those reported previously from multiple logistic regression,

but they provide better discrimination of the profile of injuries in Greek playgrounds.

Discussion

Playgrounds are a reality in modern societies and their role in the contemporary lifestyle is likely to increase progressively. To the extent that playgrounds are likely to occupy an ever-increasing fraction of children's time, their safety is of paramount importance. Playground injuries are, in general, less frequent and less severe than those sustained by children playing on the streets or even in crowded schoolyards. This fact, however, is not an excuse for reducing efforts to improve the safety of playgrounds, since the limit for injury incidence in playgrounds should and could approach a value close to zero.

The overall incidence of playground injuries in the childhood population of the Greater Athens area can be estimated only roughly with the data at hand. This is because time spent in playgrounds cannot be accurately calculated to generate a reliable person-time study base. There is good evidence, however, that the participating hospitals cover about 30% of the person-time at risk for childhood injuries in Greater Athens (6) and childhood population figures have been regularly updated by the National Statistical Service of Greece. Thus, it can be estimated that the annual incidence of playground injuries in Greater Athens is about 7 in 1000 among boys and 4 in 1000 among girls. These figures cannot be compared directly with those from other countries because patterns of playground attendance vary considerably, as do healthcare systems and hospital contact rates. Nevertheless, playground injuries represent a non-negligible fraction of all childhood injuries in Greece (4.4%).

The present study is rich in information concerning the conditions of playground accidents and the nature of playground injuries in Greece. These data could provide a first approximation to the pattern of playground accidents and injuries that are likely to be observed in other developed countries. Although results from other studies are not strictly comparable to those of this investigation, no striking differences were noted (10–18).

This investigation showed that public playgrounds are in general less safe than private playgrounds. The safety difference could possibly be partly explained in terms of specific equipment (swing, slide, seesaw, climbing frame) or even the abundance of loose stones that are frequently involved in accidents and are generally found much more frequently in public than in private playgrounds. Several earlier investigations also indicated that playground equipment, when present, is involved in the majority of injuries (1, 10, 11, 14, 17–22). For instance, in Austria more than two-thirds of playground injuries were intimately

associated with swings, slides, climbing frames, metal bars and roundabout structures (11), whereas only 10% occurred without any use of playground equipment. Other studies have explored particular characteristics of playground equipment in relation to the likelihood or the severity of injuries. As expected, height of equipment has been shown to be an aggravating factor (12, 16, 17, 23–25). The collective evidence from these studies suggests a consistently positive relation between height of equipment and the likelihood and/or severity of playground injuries, with a safety threshold at around 1.5 m. Equally important, but less easily achievable, is the compatibility of the equipment design (11, 14, 20–22) with the age of the children. Climbing frames and swings may be inappropriate for very young children (22). Maintenance is also an important factor in the complex interaction of structural and functional factors in the causation of injuries (14, 26); however, both the installation of high-standard playground equipment and maintenance are costly, and it is rare that respective guidelines are met in poor urban environments. Yet, the merits of use of the outdoor public playgrounds compared with the indoor private playgrounds, which in the Mediterranean climate mainly serve parental respite needs, in relation to the children's play and social development should be emphasized.

Another structural factor that has been documented to contribute to the causation or severity of playground injuries is the poor absorbing features of the playground surface, and this has been shown in both earlier studies and the present investigation (14, 17, 19). In the present study, the absorbing potential of the playground surface material was found to be particularly important for head injuries, including concussion, and to a lesser extent for long bone fractures. There are, however, some drawbacks associated with the resiliency of the surface which are more frequently noted in the private playgrounds: in these establishments children are often encouraged to play barefooted and this seems to increase the incidence of sprain and dislocation injuries, particularly of the ankles.

On the basis of the data of this study it was shown that 46% of all playground injuries in the Greater Athens area could have been prevented if public playgrounds were structured and equipped in a way similar to that of the private ones. There is evidence in the data, however, that further reduction in the incidence of these injuries could be achieved if both public and private playgrounds were more efficiently supervised. This conclusion did not emerge from a comparison of supervision frequencies between public and private playgrounds (55% and 60%, respectively), nor was it possible to evaluate directly the importance of supervision in the causation of an accident. This is because patterns of supervision in the absence of an accident were not available and could not be ascertained easily. A combination of logic with the low prevalence of supervision at the time of an accident in both public

and private playgrounds, however, indicated that an unknown but probably substantial fraction of injuries could be prevented by more efficient supervision. It should be noted, however, that if poorer children play more recklessly or have less supervision, then increased injury rates may reflect, to a certain extent, behaviour rather than exposure to physical hazards. Boys are known to be high risk takers and this well-known phenomenon, resulting in higher injury rates, was mainly observed in the public and to a much lesser extent in the private playgrounds in this study. This may suggest that private playgrounds are indeed safer overall. The rate ratio of boys:girls injured in public versus private playgrounds was around 1.5, a figure that may be a useful indicator of excess risk as it should take into account behavioural and supervision differences between affluent and poor people.

In conclusion, this study was fairly large and adequately designed to document in quantitative terms the role of various factors in the causation of playground injuries. The findings indicate that close to 50% of playground injuries could be prevented by structural and equipment changes. Further reductions could be accomplished through simple measures including closer supervision and encouraging children to wear proper shoes and use protective equipment when necessary. Playgrounds are an important environment in children's social life of and the need to improve safety cannot be overemphasized.

Acknowledgements.—Special thanks are due to N Dessypris for the statistical analysis and to Eleni Tsilikou and Stellina Kiosse for their contribution in the data collection.

References

- Lillis KA, Jaffe DM. Playground injuries in children. *Pediatr Emerg Care* 1997; 13: 149–53
- Laboratory Center for Disease Control, Health Protection Branch. Children's Hospital Injury Research and Prevention Program (CHIRPP) Technical Report No. 1, 1990
- EHLASS. European Home and Leisure Surveillance System (EHLASS)—Greece. Annual Report, Athens, Greece, 1997: 1–75
- World Health Organization. International classification of diseases. 9th revision. Geneva: WHO, 1977
- World Health Organization. International statistical classification of diseases and related health problems. 10th revision. Geneva: WHO, 1992
- Dessypris N, Petridou E, Skalkidis Y, Moustaki M, Koutselini A, Trichopoulos D. Countrywide estimation of the burden of injuries in Greece: a limited resources approach. Submitted for publication
- MacMahon B, Trichopoulos D. *Epidemiology: principles and methods*. 2nd ed. Boston, MA: Little Brown and Co, 1996
- Lebart L, Marineau A, Warwick KM. *Multivariate descriptive statistical analysis*. New York: John Wiley, 1984
- Mardia KV, Kent JT, Bibby JM. *Multivariate analysis*. New York: Academic Press, 1979
- Mott A, Evans R, Rolfe K, Potter D, Kemp KW, Sibert JR. Patterns of injuries to children on public playgrounds. *Arch Dis Child* 1994; 71: 328–30
- Mayr J, Russe O, Spitzer P, Mayr-Kohi M, Hollwarth ME. Playground accidents. *Acta Paediatr* 1995; 84: 573–6
- Macarthur C, Hu X, Wesson DE, Parkin PC. Risk factors for severe injuries associated with falls from playground equipment. *Accid Anal Prev* 2000; 32: 377–82
- Alkon A, Genevro JL, Tschann JM, Kaiser P, Ragland DR, Boyce WT. The epidemiology of injuries in 4 child care centers. *Arch Pediatr Adolesc Med* 1999; 153: 1248–54
- MMWR. Playground safety—United States, 1998–1999. *MMWR Morb Mortal Wkly Rep* 1999; 48: 329–32
- Waltzman ML, Shannon M, Bowen AP, Bailey MC. Monkeybar injuries: complications of play. *Pediatrics* 1999; 103: e58
- Chalmers DJ, Marshall SW, Langley JD, Evans MJ, Brunton CR, Kelly AM, et al. Height and surfacing as risk factors for injury in falls from playground equipment: a case-control study. *Injury Prev* 1996; 2: 98–104
- Mott A, Rolfe K, James R, Evans R, Kemp A, Dunstan F, et al., Safety of surfaces and equipment for children in playgrounds. *Lancet* 1997 28; 349: 1874–6
- Mack MG, Hudson S, Thompson D. A descriptive analysis of children's playground injuries in the United States 1990–4. *Injury Prev* 1997; 3: 100–3
- Bond MT, Peck MG. The risk of childhood injury on Boston's playground equipment and surfaces. *Am J Public Health* 1993; 83: 731–3
- Chalmers DJ, Langley JD. Epidemiology of playground equipment injuries resulting in hospitalization. *J Paediatr Child Health* 1990; 26: 329–34
- Boyce WT, Sobolewski S, Sprunger LW, Schaefer C. Playground equipment injuries in a large, urban school district. *Am J Public Health* 1984; 74: 984–6
- Illingworth C, Brennan P, Jay A, Al-Radii F, Collick M. 200 injuries caused by playground equipment. *Br Med J* 1975; 4: 332–4
- Briss PA, Sacks JJ, Addiss DG, Kresnow MJ, O'Neil J. Injuries from falls on playgrounds. Effects of day care center regulation and enforcement. *Arch Pediatr Adolesc Med* 1995; 149: 906–11
- Briss PA, Sacks JJ, Addiss DG, Kresnow M, O'Neil J. A nationwide study of the risk of injury associated with day care center attendance. *Pediatrics* 1994; 93: 364–8
- Sacks JJ, Holt KW, Holmgreen P, Colwell LS Jr, Brown JM Jr. Playground hazards in Atlanta child care centers. *Am J Public Health* 1990; 80: 986–8
- Hudson S, Thompson D, Mack MG. The prevention of playground injuries. *J Sch Nurs* 1999; 15: 30–3

Received July 18, 2001; revision received Nov. 20, 2001; accepted Feb. 7, 2002