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More people more active, but there is a counter site. Novice athletes are at highest risk of injury in a large population-based retrospective cross-sectional study

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ABSTRACT

Objectives To evaluate whether in fitness-related activities and recreational running over time, there is an increase in the number of novice sports athletes and whether these novice athletes have an increased injury rate compared with their experienced counterparts.

Methods Data were collected from a large population-based retrospective cross-sectional study, 'Injuries and Physical Activity in the Netherlands' (IPAN). Athletes aged ≥18 years were included. We used descriptive statistics to describe the characteristics of athletes and their injuries. The number of athletes and injuries were calculated for each year and, where applicable, for each sport separately. The injury incidence rate was expressed as the number of injuries per 1000 hours of exposure. Logistic regression analyses were performed with non-extrapolated data to analyse the differences in injury risk for novice and experienced athletes included in this study, separate for fitness-related activities and running.

Results Over the 5 years, 9209 fitness athletes reported 370 fitness-related injuries, 5426 runners reported 537 running-related injuries. Weighted data showed that, in 2010–2014, the inflow of novice fitness athletes slightly decreased, whereas the inflow of novice runners slightly increased. In each year, injury risk was higher in novice athletes compared with experienced athletes for both fitness-related activities and running. The injury incidence rates in running are much higher than in fitness-related activities.

Conclusions Over the years 2010–2014, the absolute number of novice athletes in fitness-related activities and running together increased. Although most injuries occurred in experienced athletes, injury risk was higher in novice athletes in both sports.

Key messages

What is already known

- The promotion of physical activity is a cornerstone of contemporary public health.
- Novice participants have a distinctly higher risk of injury than more experienced participants.
- With the contemporary focus on physical activity promotion, more physical activity and sports participants can be expected, and, thus, the number of novice participants with a higher risk of injury is expected to increase.

What are the new findings

- Over the years 2010–2014, the inflow of novice fitness athletes in absolute numbers slightly decreased, the inflow of novice recreational runners increased.
- Although, in absolute numbers, most injuries occurred in experienced athletes, injury risk was highest in novice athletes in both fitness-related activities and running.

INTRODUCTION

The impact of (in)sufficient levels of physical activity has been well described and, without argument, the promotion of physical activity is now a cornerstone of contemporary public health.[1 2] Although evidence suggests that participation in sport, recreation and physical activity are beneficial from a health perspective, injuries incurred during these activities have significant short and long-term negative side effects. These injuries are an important contributor to total disease morbidity. Within the EU, for instance, it was estimated that as a result of participation in sport, 5.8 million acute injuries are sustained and treated at emergency departments (EDs) annually across all age groups and levels, and 24.6 million acute injuries for home, leisure (including physical activity) and sport activities in total.[3–5] Next to a burden to the injured individual, these injuries pose a substantial societal burden as well. This societal impact is clearly illustrated by the approximated short-term costs alone, which sum up to 50 billion € per year for home, leisure and sport injuries treated at EDs.[4] The actual costs of injury are likely to be much higher, due to, for example, sick pay, cost for treatments outside

of hospital, costs for rehabilitation, disability pensions and loss of productivity.

The short-term and long-term benefits of sufficient physical activity and participation in sport outweigh by far the potential negative consequence. Yet, this does not mean that we can ignore the existence of such side effects.[6] Especially given reports suggesting that novice and recreational participants have a distinctly higher risk of injury than more experienced participants. A review on injury rates in long distance runners, for instance, established that novice runners have a higher injury rate (2.56 injuries/1000 hours; 95% CI 2.55 to 2.60) than recreational runners (2.06 injuries/1000 hours; 95% CI 1.70 to 1.90), who, in turn, have a higher injury rate than competitive runners (1.55 injuries/1000 hours; 95% CI 1.54 to 1.56).[7] Similar differences have been found for children[8] and soccer.[9]

With the contemporary focus on physical activity promotion,[1 2] more physical activity and sport participants can be expected, and, thus, the number of novice participants will logically increase. In the Netherlands, for instance, adults participate mostly in fitness-related activities and recreational running, and between 2001 and 2018, both sports have seen an increase in participation rates of, respectively, 10,8% and 6,7%.[10] In line with such a development, the number of injuries in these sports is hypothesised to accrue at an increased rate. The current analysis evaluated for fitness-related activities and recreational running—based on population participation and injury data—whether there is an increase over time in the number of novice athletes and whether these have an increased injury rate compared with their experienced counterparts.

METHODS

To provide insight into the number of novice athletes and their injury risk compared with their experienced counterparts, data were collected from a large population-based retrospective cross-sectional study, 'Injuries and Physical Activity in the Netherlands' (IPAN). IPAN is an existing database, data were registered anonymously, and respondents cannot be traced with this data.

Patient and public involvement

Given the research design, it was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting or dissemination plans of our research.

Injuries and physical activity in the Netherlands

IPAN was a continuous national questionnaire on accidents, injuries, sport participation and physical activity, operated by the Dutch Consumer Safety Institute (VeiligheidNL) from 2010 till 2014. IPAN consisted of a general section in which information on demographic characteristics, general health and activity, occupation, education was gathered, and four accident or injury-specific sections: traffic accidents, home and leisure accidents, sport injuries and occupational accidents.

All respondents of IPAN were participants of InterviewBase, a database of around 238 000 people in the Netherlands willing to contribute to research. New respondents for this database were continuously recruited on the internet or by random digit dialling. Each year, a representative sample of around 11 000 members was questioned for IPAN, either by telephone or online. To optimise the representativeness, sociodemographic quotas for this sample were established in advance. During the 5 years used for this study (2010–2014), 43 508 respondents aged 18 and older were questioned for IPAN. To correct for differences in non-response within the quota groups, the data were standardised to the Dutch population by weighing the questionnaire data for age, gender, level of education, employment, urbanity, living region and household size based on data from the Dutch Central Bureau of Statistics, using random iterative method weighting.[11]

Data selection procedure

For the present study, data were used from the general and sport injury sections of IPAN. Athletes aged ≥18 years were included in this study. In IPAN, a maximum of four sports were registered per athlete. This study included fitness-related activities and running because Dutch adults participate mostly in fitness-related activities and recreational running. Both sports have seen increased participation rates between 2001 and 2018.[10] Fitness is an umbrella term for all sports usually practised in a gym. The activities can be divided in cardio fitness, such as home trainer, treadmill, rowing machine; weight training/body building: weightlifting fitness equipment, weight lifting/squats, use of dumbbells; group fitness: CrossFit, aerobics, Pilates, Zumba, spinning, Steps, bootcamp, body balance, body shape, body pump, callisthenics.

Information on sports experience (novice or experienced) and hours of sport participation were gathered per sports type. Athletes who started a sport during the past 12 months were defined as 'novice' in this sport. Those who participated in a sport for more than 12 months were defined as 'experienced'. Hence, an athlete could be both novice in one sport and experienced in another sport.

Per sport, exposure per athlete was calculated. The reported average weekly exposure (sessions per week * time per session in hours) was multiplied by the number of weeks per year an athlete reported being active in that sport. The total amount of sport participation per athlete was the sum of the total hours of sport participation per sport.

In IPAN's sport section, information on sport injuries was gathered. The recall period for reporting injuries was set at 3 months. With the first day of the recall period, always set at the beginning of a month—and respondents were interviewed on all days of the month—individual respondents recall period could range from 3 to 4 months. Therefore, the length of the recall period was set on an average of 3.5 months.[12] To calculate the annual number of new injuries per sport, the registered self-reported number of injuries within the recall period was

multiplied by 12/3.5. Athletes could report a maximum number of two new sport injuries within the recall period. Before an injury was included in the analyses, one of the authors (EK) checked that it agreed with the (general) sport injury definition by Schmikli *et al*: 'Physical damage of a musculoskeletal nature as a result of a sudden event during a sports activity or as a result of a gradual process related to sports activity'.[12] A minimum of 50 new injuries per sport per year was chosen for the reliability of the analyses. This assumption was met for both fitness-related activities and running.

While athletes could be active in more than one sport, information on sports experience (novice or experienced) was established per sport separately. Hence, we display information of novice and experienced athletes for fitness-related activities and running separately.

Statistical analysis

We used descriptive statistics to describe the characteristics of athletes and their injuries. We calculated the number of athletes and the number of injuries each year and, when applicable, for each sport separately. The injury incidence rate was expressed as the number of injuries per 1000 hours of exposure. The injury incidence rate and 95% CI were calculated manually in Microsoft 365 Excel. Logistic regression analyses were performed with non-extrapolated data to compare the odds for injury between novice and experienced athletes, separate for fitness-related activities and running. The year of response (2010–2014) and exposure (hours of fitness-related activities or running) were included in the model as covariates. Analyses were controlled for effect modification by adding interaction terms. We performed all analyses using the Statistical Package for the Social Sciences (IBM SPSS, V.23.0), with a significance level of $p<0.05$.

RESULTS

In our study over 5 years, 28 773 athletes aged 18 years and older reported a total of 2903 sport injuries. Of the 28 773 athletes in 2010–2014, 9209 were active in fitness-related activities (37% male, mean ages 41.9 years; SD 15.3), and 5426 were runners (52% male, mean age 35.5 years; SD 11.8). In total, over the 5 years, the fitness athletes reported 370 fitness-related injuries, the runners reported 537 running-related injuries. The reported injuries per sport per year ranged from 55 (fitness, 2011) to 132 (running, 2014).

Sports participation and injuries in the Netherlands

Weighted data showed that, in 2010, 8.77 million individuals in the Netherlands aged 18 and older participated in sports. This corresponded to approximately 53% of the total Dutch population. Between 2010 and 2014, this number increased to 9.17 million. The total number of sport injuries and the injury incidence rate gradually increased over time (table 1).

Fitness-related activities

Over our 5-year period, the number of fitness athletes increased from 2.64 million to 2.94 million (table 2). In 2010, almost one-third of the fitness athletes were considered a novice. In 2014, the percentage of novice fitness athletes in the fitness population had decreased to 25%. Over the years, the number of injuries in fitness-related activities gradually increased from 304 000 in 2010 to 487 000 in 2014, and most injuries occurred in experienced fitness athletes. The incidence rate of fitness injuries significantly increased from 1.3 (95% CI 1.24 to 1.38) injuries per 1000 hours of participation in 2010 to 1.8 (95% CI 1.72 to 1.88) injuries per 1000 hours of participation in 2014. Each year, the injury incidence rate in novice fitness athletes was higher than in experienced fitness athletes (figure 1 and table 2).

A logistic regression analysis was performed on non-extrapolated data to analyse the odds for injury for all novice and experienced fitness athletes, taking the year of response (2010–2014) and exposure (hours of fitness) into account. No effect modification was found. The OR for sustaining a fitness-related injury did not differ between novice and experienced fitness participants (OR 0.91; 95 CI 0.74 to 1.13; table 3).

Running

Over the 5 years, the number of runners increased by more than half a million (table 4). There was an increase in both experienced and novice runners. With increasing numbers of runners, the number of injuries increased as well. The number of injuries for all runners doubled over 5 years from 336 000 to 688 000, and most injuries occurred in experienced runners. Like experienced fitness athletes, experienced runners are, on average, also more active in running than their novice counterparts. Each year, the injury incidence rate in novice runners is significantly higher when compared with experienced runners (see also figure 2).

Table 1 Athletes and injuries in the Netherlands over the period 2010–2014

	2010	2011	2012	2013	2014
Athletes	8 770 000	8 740 000	8 990 000	9 370 000	9 170 000
Injuries	2 820 000	2 970 000	3 300 000	3 470 000	3 590 000
Injured athletes (%)	11.6	12.5	13.0	13.0	14.0
Injuries/1000 hour sports	1.8	1.8	2.0	2.0	2.1

Table 2 Fitness athletes and injuries in the Netherlands over the period 2010–2014

	2010	2011	2012	2013	2014
Total fitness athletes	2 640 000	2 630 000	2 920 000	2 950 000	2 940 000
Experienced fitness athletes, n (%)	1 770 000 (67.4%)	1 820 000 (69.3%)	2 060 000 (70.8%)	2 140 000 (72.5%)	2 210 000 (75.2%)
Novice fitness athletes, n (%)	862 000 (32.7%)	808 000 (30.7%)	851 000 (29.2%)	812 000 (27.5%)	728 000 (24.8%)
Injuries total	304 000	298 000	400 000	421 000	487 000
Injuries experienced, n (%)	181 000 (59.5%)	242 000 (81.0%)	288 000 (72.1%)	310 000 (73.7%)	359 000 (73.7%)
Injuries novice, n (%)	123 000 (40.5%)	56 600 (19.0%)	112 000 (27.9%)	111 000 (26.3%)	128 000 (26.3%)
Mean h/y total	88.2	97.5	96.3	98.5	92.1
Mean h/y experienced fitness athletes	95.9	114.4	107.1	107.3	101.3
Mean h/y novice fitness athletes	72.1	58.5	69.5	74.8	63.4
Injuries/1000 hours fitness total (95% CI)	1.3 (1.24 to 1.38)	1.2 (1.10 to 1.23)	1.4 (1.35 to 1.50)	1.4 (1.37 to 1.52)	1.8 (1.72 to 1.88)
Injuries/1000 hours fitness experienced (95% CI)	1.1* (1.00 to 1.13)	1.2 (1.09 to 1.23)	1.3* (1.23 to 1.38)	1.4* (1.28 to 1.42)	1.6* (1.53 to 1.68)
Injuries/1000 hours fitness novice (95% CI)	2.0* (1.90 to 2.07)	1.2 (1.13 to 1.27)	1.9* (1.81 to 1.98)	1.8* (1.74 to 1.91)	2.8* (2.67 to 2.87)

*Significant difference between novice and experienced athletes.

A logistic regression analysis was performed on non-extrapolated data to analyse the odds for injury for all novice and experienced runners over the 5-year study period. Similar to fitness-related activities, response year and hours of running were included in the model as covariates. No effect modification was found. The Odds for sustaining a running injury was higher for novice runners than for experienced runners (OR 1.19; 95 CI 1.00 to 1.42; table 5). Both response year and exposure were associated with the occurrence of a running-related injury as well.

DISCUSSION

In this study, we analysed whether, over time, there was an increase in the number of novice athletes in fitness-related activities and recreational running and whether novice athletes had a higher injury rate compared with their experienced counterparts. Between 2010 and 2014, weighted data showed that the inflow of novice fitness athletes slightly decreased, while the inflow of novice runners slightly increased. Although in, both sports most injuries occurred in experienced athletes, the injury risk was higher in novice athletes.

Considering the vision of Exercise is Medicine, a global health initiative managed by the American College of Sports Medicine and the WHO, physical activity has significant health benefits for the heart, body and mind. Hence, the ongoing promotion of physical activity will be a cornerstone of public health.[1] The promotion of sustainable sports is warranted. In our study, we observed a rather steady inflow of novice athletes. It is plausible that these novice athletes remained active, as there was

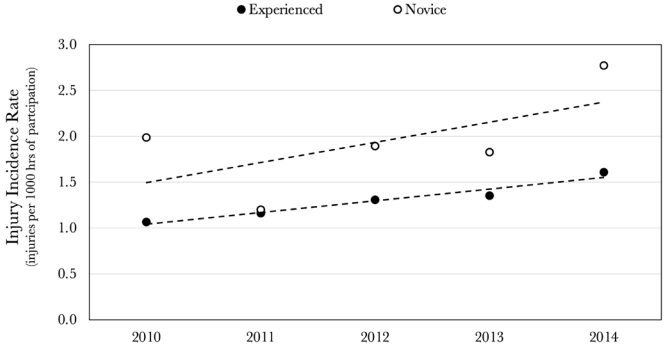

Figure 1 Incidence rates fitness-related injuries in 2010–2014 in the Netherlands.

Table 3 Logistic regression analyses for sustaining a fitness-related injury

	OR (95% CI)	P-value
Experience (novice vs experienced)	0.91 (0.74 to 1.13)	0.416
Response year		0.384
2010	Reference category	
2011	1.08 (0.78 to 1.49)	0.636
2012	1.14 (0.83 to 1.55)	0.416
2013	1.16 (0.85 to 1.58)	0.342
2014	1.34 (.099 to 1.81)	0.056
Hours of exposure	1.00 (1.00 to 1.00)	0.000

Table 4 Runners and running-related injuries in the Netherlands over the period 2010–2014

	2010	2011	2012	2013	2014
Total	1 290 000	1 350 000	1 710 000	1 840 000	1 850 000
Experienced runners, n (%)	942 000 (73.2%)	954 000 (70.5%)	1 220 000 (71.1%)	1 290 000 (70.4%)	1 400 000 (75.6%)
Novice runners, n (%)	346 000 (26.8%)	400 000 (29.5%)	494 000 (28.9%)	543 000 (29.6%)	452 000 (24.4%)
Injuries total	336 000	425 000	569 000	629 000	688 000
Injuries experienced runners, n (%)	216 000 (64.4%)	305 000 (71.9%)	382 000 (67.3%)	426 000 (67.7%)	485 000 (70.4%)
Injuries novice runners, n (%)	120 000 (35.6%)	119 000 (28.1%)	186 000 (32.7%)	203 000 (32.3%)	204 000 (29.6%)
Mean h/y total	55.6	59.1	60.8	61.2	59.1
Mean h/y experienced runners	62.1	64.7	68.1	70.6	64.7
Mean h/y novice runners	37.3	40.5	43.1	38.6	40.5
injuries/1000 hours running total (95% CI)	4.7 (4.56 to 4.83)	5.3 (5.17 to 5.45)	5.5 (5.33 to 5.62)	5.6 (5.46 to 5.75)	6.3 (6.13 to 6.44)
Injuries/1000 hours running experienced (95% CI)	3.7* (3.58 to 3.82)	4.9* (4.80 to 5.08)	4.6* (4.48 to 4.75)	4.7* (4.53 to 4.80)	5.3* (5.20 to 5.49)
Injuries/1000 hours running novice runners (95% CI)	9.3* (9.10 to 9.48)	7.4* (7.20 to 7.54)	8.8* (8.57 to 8.93)	9.7* (9.50 to 9.88)	11.1* (10.90 to 11.32)

*Significant difference between novice and experienced athletes.

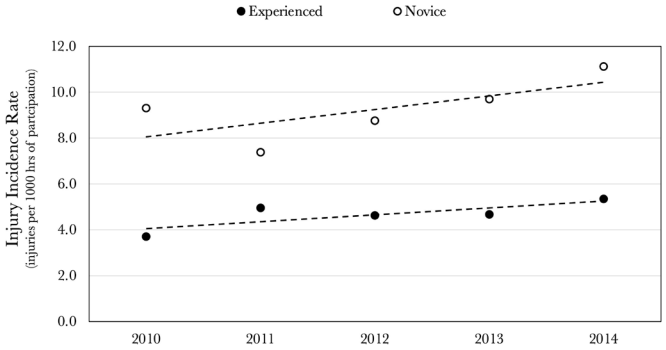

Figure 2 Incidence rates running-related injuries in 2020–2014 in the Netherlands.

a steady increase in fitness athletes and recreational runners over the years. These increasing numbers can be a representation of the successful promotion of physical activity in the Netherlands.

The possibility to sustain an injury is associated with being active in sports and physical activity. With increasing numbers of athletes, the number of injuries increased in both sports. Novice athletes did have a higher risk for injury than their experienced counterparts. An injury is one of the main reasons to quit physical activity.[13 14] With all the extra attention for becoming physically active and starting to participate in sports, especially in populations that are less physically fit, the number of injuries will likely increase with increasing numbers of novice athletes, limiting the additional value of physical activity for these athletes. Hence, we believe that attention to prevention is necessary to prevent early drop-out of sports of novice athletes.[6]

Not only is the injury risk of novice athletes higher but the duration of injury in novice athletes also is relatively long, specifically in novice runners,[15] and a tendency towards receiving medical attention more frequently was found as well.[16] Sport injuries are rarely the result of a single factor,[17 18] nor will the differences in injury risk between novice and experienced athletes be. A consequence of this higher injury risk, long absence and healthcare consumption, and difference in risk factors, is that universal injury prevention is insufficient. Injury prevention should be context specific and focusing on a target group, in this case, the novice athletes. Research has demonstrated that many sport injuries can be prevented in ideal or pragmatic conditions.[19] For example, for organised team sports in the Netherlands like, for example, soccer (FIFA 11+), volleyball[20] and field hockey,[21] effective injury prevention programmes exist. So far, not much evidence for injury prevention in novice athletes in running or fitness-related activities is available, neither in ideal nor in pragmatic conditions.

Although injury prevention is complicated, one aspect of novice athletes makes it even more difficult. An important aspect of being a novice athlete is the aspect of being unconscious incompetent, referring to the first stage of the 'four stages of competence'.[22] Novice athletes, or most of them, do not understand or know how to prevent injuries and do not necessarily recognise the importance of prevention. If you do not have any experience with having a sport injury, you might not feel the urge to protect yourself against injury. Injury prevention is not a conscious decision for recreational runners but a tentative to control and influence the injury through a self-regulation process.[23] Hence, we believe that effective interventions for experienced athletes should not simply be applied to beginners. As novice athletes differ from their experienced counterparts, and (implementation of) prevention is precarious, more research is needed to gain insight into novice athletes' 'complex world', their beliefs, motivation, knowledge, etcetera. Only then prevention for novice athletes might work.

Table 5 Logistic regression analyses for sustaining a running-related injury

	OR (95% CI)	P-value
Experience (novice vs experienced)	1.19 (1.00 to 1.42)	0.045
Response year		0.012
2010	Reference category	
2011	1.06 (0.79 to 1.42)	0.695
2012	1.28 (0.98 to 1.68)	0.073
2013	1.28 (0.98 to 1.70)	0.071
2014	1.51 (1.16 to 1.97)	0.002
Hours of exposure	1.00 (1.00 to 1.00)	0.000

Limitations

Some limitations of this study need to be addressed. First, all information in IPAN are based on self-report. Although this method may not yield the highest quality data because of potential patient bias[24] and socially desirable responses, collecting information in large cohorts on all injuries, including less severe ones, is highly practical. Second, we classified athletes who had been active for less than a year as novice and athletes who had been active for more than a year as experienced. The choice for a 1-year boundary to distinguish between novice and experienced athletes is debatable. Athletes with more than 12 months of experience still could be very 'novice'. Athletes with 13 months of being active in sports once a week might be less experienced than those with 11 months of physical activity once a week. This is not considered in this study. Injury data in this study are not further specified for, for example, type of injury, injury location and different types of runners are grouped based on experience only. Although we believe that such specifications can be of interest, in this study, we chose otherwise because they are not directly related to the common thread of this study. Finally, there is a risk of recall bias. We asked athletes to answer questions concerning the last 3 months. This recall bias and the accuracy of self-reporting of sport injuries depend largely on the length of the recall period.[25 26]

A recall period of 1–3 months is recommended for injury questionnaires,[27] similar to that used in our study.

CONCLUSION

Over the years 2010–2014, the inflow of novice athletes ranged from 24.4% to 32.7%; the inflow of novice fitness athletes slightly decreased, whereas the inflow of novice runners slightly increased. The absolute number of novice athletes in fitness-related activities and running together increased. Although most injuries occurred in experienced athletes, injury risk was higher in novice athletes in both sports. As lasting physical activity is beneficial for one's health, we believe that attention to prevention is necessary for novice athletes to prevent early dropout of sports. Furthermore, injury prevention should be context specific and focusing on the target group of interest.

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Contributors EK was responsible for the conceptualisation of the idea of the study, data analyses, interpretation of the data and preparation of the manuscript. HV was responsible for the interpretation of the data, and the critical review of the manuscript. EV was responsible for the conceptualisation of the idea of the study, interpretation of the data and preparation of the manuscript. All authors read and approved the final manuscript.

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Competing interests EV is an Editorial Board Member of BMJ Open Sport & Exercise Medicine.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval To provide insight into the number of novice athletes and their injury risk compared to their experienced counterparts, data were collected from a large population-based retrospective cross-sectional study, 'Injuries and Physical Activity in the Netherlands' (IPAN). IPAN is an existing database, data were registered anonymously, and respondents cannot be traced with this data. Consequently, no Ethics Committee approval was acquired.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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