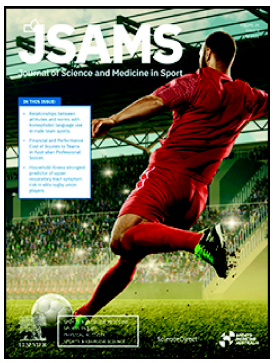

Applying an ecosystem approach to explore modifiable factors related to the risk for low motor competence in young children

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Applying an ecosystem approach to explore modifiable factors related to the risk for low motor competence in young children

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Abstract

Objectives: Early childhood is a crucial phase for motor development in which differences between children can manifest. These differences might be related to factors in ecosystems in which children are raised, of which little is currently known. The current study's purpose was to explore which modifiable factors in children's ecosystems are associated with the odds for low versus higher motor competence (MC) in 4- to 6-year-old children.

Design: A cross-sectional study design was conducted to investigate which modifiable social and physical factors in the home environment and direct living environment were associated with differences in MC.

Methods: Children's MC was measured through the Athletic Skills Track in 612 4- to 6-year-olds, from 10 primary schools in Eindhoven, the Netherlands. Parenting practices, characteristics of the home environment, and perceptions of the direct living environment were assessed through parental questionnaires. Hierarchical logistic regression analyses were conducted to evaluate factors associated with low MC in children.

Results: The presence of a garden at home and higher perceived sports facilities in the direct living environment decreased the likelihood of children being classified as low MC. Moreover, stronger parental active transportation routines and more discouraging physical activity parenting practices resulted in lower odds of low MC. In addition, girls were more at risk for low MC.

Conclusions: Characteristics of the social and physical home environment and direct living environment were associated with MC disparities during early childhood. Both parenting practices and parental physical activity-involved behaviours are relevant modifiable factors related to differences in children's MC.

Keywords: Child; Motor Skills; Parents; Neighbourhood; Practices; Primary Prevention

Introduction

Children's motor competence (MC) has declined in recent decades[1], which is alarming as this is associated with decreased fitness[2], lower levels of physical activity (PA), and higher levels of sedentary behaviour (SB)[3], as well as with developmental delay in young children[4]. Further, MC is negatively associated with weight status[5]. As the development of MC starts during early childhood[6] and is conceptually interrelated with PA, preventing any delays or deficiencies in MC and PA during this period is vital from a public health perspective[7]. Yet, a majority of studies focused on curation of existing deficiencies in MC[8]. In parallel, most research on determinants of MC has been conducted on relatively strong but non-modifiable individual factors, such as age, gender and cultural background, whereas some more recent studies have looked at more modifiable socio-ecological factors of MC in children[5]. To some extent, inter-individual MC differences will always be present due to individual factors[9], but increased understanding of the role of environments to which children are exposed the most during their first years of life can lead to more equal developmental opportunities for each child[7]. For example, Niemisto[10] reported that more supporting outdoor environments in the vicinity of childcare centres (i.e. less residential density) fosters children's MC development. Other studies have also highlighted important modifiable factors of MC and PA within the physical and social environments of childcare settings[11]. However, as young children spend a substantial proportion of time at home, more empirical evidence is needed on modifiable factors of children's MC within the broader socio-ecological system of their home setting.

Empirical evidence on the interacting influence of the physical and social environment in the home and neighbourhood setting on young children's MC is scarce[12]. For example, Barnett[13] found that availability of appropriate play equipment in the home setting was associated with better locomotor and object control skills in children. Likewise, parental modelling behaviour and parenting practices may be important factors for young children, as parents are considered 'gatekeepers' to either facilitate or restrict their child from viable motor learning experiences[10] and PA or SB[14]. Most research conducted on the associations between parents and young children's MC focus on parental beliefs, cognitive factors concerning the importance of PA, and parental PA behaviour[15]. Physical activity

parenting practices (PAPPs) are more proximal factors for actual parenting behaviour that can be observed in and experienced by children[16]. To date, however, associations between PAPPs and children's MC are less well documented.

Therefore, the purpose of the current study was to explore whether physical and social environmental factors in the home environment and direct living environment are associated with MC. In order to effectively intervene during early childhood, it is vital to prioritize children that would benefit most from an intervention and also target relevant modifiable factors. Therefore, it is of interest to investigate whether children with low MC would show different modifiable home- and living conditions compared to children with normal or high MC, as this can have significant impact on future interventions. Consequently, this study wants to contribute to developing new ideas on how to prevent and reduce MC disparities and inequalities during early childhood.

Methods

The current exploratory study used a cross-sectional research design in which a convenience sample of 10 primary schools located in Eindhoven, the Netherlands participated. Children in grades 1 and 2 (4-6 years old) in these schools were eligible for participation. Data were part of a larger cross-national project on children's fundamental MC development, 'Start(V)aardig'. Parents received written information about the study and were asked for written consent to participate in the study. In total, 701 parents (64.1%) consented. Children's measures included MC and body height and weight. Additionally, all participating parents received a questionnaire in which physical and social factors in the home environment and direct living environment were measured. Data collection took place in the period January-February 2020, just before restrictions came into force as a result of the COVID-19 pandemic. Child measures were collected through school visits by a team of trained researchers, while questionnaires were attached to the informed consent form. Ethical approval was obtained by the Ethical Research Committee of the Free University (VU) in Amsterdam, the Netherlands (VCWE-2020-137).

Children's MC was measured by the Athletic Skills Track (AST)-1. The AST is a feasible tool for measuring children's MC in a physical education setting[17]. AST-1 showed high test-retest reliability, an acceptable level of internal consistency and high validity compared to the Körperkoordinations Test für Kinder (KTK)[17]. This circuit-based measurement tool was designed for children in grades 1 and 2 and consists of 5 consecutive activities: 1) walking/balancing; 2) travelling jumps; 3) alligator crawl; 4) slaloming; and 5) clambering. Children were instructed to complete the track in bare feet as quickly as possible. After receiving their instructions, the children were allowed to go on a practice round of the circuit three times before the actual test trial. Children's time to complete the track was measured in seconds (1 decimal). Next, gender- and age-related cut-off values, based on a Dutch national reference sample, were applied to classify children into five MC-categories; very low (n=73; 11.9%), low (n=125; 20.4%), average (n=301; 49.2%), high (n=74; 12.1%) and very high (n=39; 6.4%). In order to evaluate meaningful differences with sufficiently large categories of children, we decided to further collapse these five categories as having very low or low MC (category 1), having an average MC (category 2) or having high or very high MC (category 3)[18].

Children's body height and weight were measured in gym clothes, without shoes. Height was measured with an accuracy of 1mm using a stadiometer (Seca 217, Hamburg, Germany) and weight using a digital scale with an accuracy of 0.1kg (Seca 878dr, Hamburg, Germany). Children's BMI was defined by weight (kg) divided by height $(m)^2$. The IOTF-based cut-off values were applied to classify weight status (underweight till overweight).

Physical activity parenting practices (PAPPs) were measured using a questionnaire comprising 27 statements on how often parents used a certain practice[19]. A Dutch translation was applied based on pre-school PAPPs, that were contextually transferred from a childcare context to the home environment as applied by Harms[20]. Each statement was measured using a 5-point Likert scale (1=never through 5=always). These statements were clustered into 16 encouraging practices, e.g. 'How often do you play active games with your child?' (α=0.75), and 11 discouraging PAPPs, e.g. 'How often do you keep your child busy with inactive activities?' (α=0.65). For both clusters the mean

score for all single items were used (1-5). In addition, we measured parental active transportation routines (PATRns) using 5 statements (α=0.82) using a 5-point Likert scale (1='I totally disagree' through 5='I totally agree')[21]. Examples of items of the PATRns scale are 'Going somewhere by foot is a habit for me.' and 'If I travel short distances, I always tend to walk or ride my bike'. Negatively framed items were recoded to ensure a positive score being linked to a positive behavioural outcome.

In addition, parents were asked about their perception of the physical and social characteristics of the home and direct living environment. Physical home environmental factors were measured through the availability of play opportunities at home, i.e. space and suitability either indoors and outdoors, based on the Environmental and Policy Evaluation Observation as a Self-Report (EPAO-SR) instrument[22]. Perceptions of physical affordances in the neighbourhood in which they lived were measured using single-item statements on the supportiveness for being physically active in terms of active play (availability of playgrounds) and sports (availability of sports facilities), which previously turned out to be relevant factors for young children's outside play[23]. Perceptions of the supportiveness of the social environment in the direct living environment were measured through traffic safety, social safety, and availability of peers to play with. All statements could be answered on a 5-point Likert scale (1='I totally disagree' through 5='I totally agree'). Finally, additional factors in the questionnaire were parental educational level, cultural background, and number of siblings present in the household. Parental educational level was classified into three levels according to the UNESCO's International Standard Classification of Education, while cultural background was dichotomized into Western versus non-Western background according to the definitions applied by the Statistics Netherlands.

To examine whether children with low MC would have different physical or social conditions in their home and direct living environment compared to children with higher MC, hierarchical logistic regression analyses were conducted with a dichotomous representation of MC categories (i.e. low MC versus average- and high MC). In this way, we investigated which factors significantly contributed to the odds of children's classification as low MC compared to average- or high MC. Based on the social-ecological framework variables were entered hierarchically, differentiating between first socio-

demographic (most proximal), then variables of the home environment, and finally variables in the direct living environment of children (most distal). The first model consisted of demographic covariates (i.e. age, gender, BMI, number of siblings of the child, and cultural background and parental educational level). The second model was complemented by three social factors in the home environment (i.e. encouraging PAPPs, discouraging PAPPs and PATRns). The final model was enriched with parental perceptions of the physical and social environment in the neighbourhood, which were operationalised as presence of a garden and the perception of availability of playgrounds, availability of sports facilities, traffic safety concerns, social safety concerns, and presence of peers. Statistical analyses were performed using SPSS 25.0 (IBM Corp, Armonk, NY, USA) and statistical significance was defined as $p<0.05$.

Results

In total, 612 children (87.3% of consenting children) provided valid measures on the Athletic Skills Track. The main reason for drop-out was absence during the measurement day at schools (N=77). The mean age of the participating children was 5.22 (SD=0.62) years, with a mean BMI of 15.37 (SD=1.31) kg/m^2. We found roughly equal distributions of IOTF-based under- and overweight percentages across the MC-categories. Gender was equally distributed (N=308 boys and N=304 girls). A majority of the children had one sibling (59.5%), were raised in a family with a Western cultural background (75.8%) and by highly educated parents (66.7% at least bachelor education). The sample was lightly skewed towards low MC; 198 (32.4%) children were classified as having a very low or low MC, while 113 (18.5%) children were classified as having a high or very high MC with respect to the age- and gender-specific national cut-off values. The percentage of girls was higher in the low MC category compared with the average- and high MC. Conversely, boys showed higher percentages in high MC compared to average- and low MC (Table 1). Moreover, the relative contribution of girls compared to boys was significantly higher in low MC (OR=1.63; $p<0.01$), but lower in high MC (OR=0.61; $p<0.01$).

Of the 612 children that participated in the measurements, 610 (99.7%) parents returned a completed questionnaire. Encouraging physical activity parental practices (PAPPs) were expressed more often than discouraging practices, while a large variation was observed in parental active transportation routines (PATRns) (M=2.70; SD=1.67). Over 85% of our sample had access to a garden. Neighbourhoods were perceived as supportive in terms of availability of playgrounds (M=4.44; SD=0.93), availability of sports facilities (M=3.84; SD=1.22), availability of age-related peers (M=3.59; SD=1.32) and, in general, parents expressed low concerns about social safety issues (M=2.27; SD=1.24). Concerns about traffic safety varied across respondents (M=3.03; SD=1.45), while increasing with age (Table 1). Further, differences between MC classifications were found for parental perceptions of sports facilities in the living environment ($F_{2,576}$=3.181, p=0.04). However, post-hoc analyses revealed only marginally significant differences between low and average MC (p=0.07) and low and high MC (p=0.10). Observed differences between MC categories for the presence of number of siblings and PATRns were non-significant.

Logistic regression models showed that girls were more than twice as likely to be categorised as low MC than in the category average or high MC (OR=2.20; p<0.01). In addition, more discouraging PAPPs (OR=0.48; p=0.01) and stronger PATRns (OR=0.79; p=0.03) were found to be social home environmental factors that decreased the likelihood of children being classified as low MC compared to high- and average MC categories. The presence of a garden decreased the likelihood of children being classified as low MC (OR=0.84; p=0.02). Moreover, children whose parents perceived higher availability of sports facilities in their direct living environment were less often classified as low MC (OR=0.80; p=0.02) (Table 2). Nagelkerke's R^2 was .115 and increased significantly while adding environmental factors.

Discussion

The main finding of the current study is that the MC of 4- to 6-year-old children is associated with several modifiable factors in the social and physical home environment and direct living environment. This knowledge can help us to prevent MC differences during early childhood.

In early childhood, we found gender-related differences in MC. Although these gender differences have been consistently found in MC[7], this shows that girls in our sample had relatively lower MC compared to the age- and gender specific national representative sample. The gender specific cut-off values allowed girls to spend slightly more time to accomplish the AST[18]. An explanation for this may be partly attributed to a sampling effect, with relatively more girls living in (more urbanised) vulnerable neighbourhoods with fewer affordances in their physical environment. Namely, earlier studies showed that these neighbourhood factors were related MC development[10]. Another explanation may be that young boys are more allowed and encouraged to be physically active, irrespective of PA-related barriers that parents experience in their ecosystem[24]. Consequently, young girls' PA and MC may be more vulnerable for these barriers. Future studies are recommended to further unravel these gender differences.

The relationship between higher PATRns and decreased odds of low MC might be explained by the habitual character of PA behaviour that is reflected in PATRns. If parental routines in using active transportation are stronger, children implicitly observe active behaviour by role models, which is in line with positive association between parental, mostly maternal, PA and children's MC[13,15]. Particularly in early childhood, children tend to copy behaviour as a way of learning. The more frequent use of active transportation by parents could either be considered as a good example for the child to be physically active, but may also be considered as a proxy of an active lifestyle. The latter may also be an explanation for the positive relationship that was found between the perceived availability of sports facilities in the direct living environment and decreased odds of low MC. The parent-perceived availability of sports facilities is associated with higher levels of sports participation in adults[25], so it could be hypothesised that these parents perform sports themselves more often, again implicitly setting a good example as a role model for their young children[14].

In line with previous work[26], the presence of a garden was linked with lower odds of being categorised as low MC. The presence of gardens could be considered as an indicator of lower levels of residential density, higher neighbourhood SES status, and better affordances for children to be physically active[27]. Gardens may be important environments for MC development in young children, as these can serve as PA affordance regardless of potential (safety) barriers that parents perceive in their neighbourhood. Additional sensitivity analyses in our study also showed significant positive correlations between the presence of gardens and a Western cultural background, slightly higher educational levels, the presence of more peers and siblings to support PA, and better perceived physical PA supportiveness of neighbourhoods (Supplementary Table S1). Consequently, the presence of gardens is not a modifiable factor, but this advocates the compensation for this lack of opportunity to create more supportive physical and social environments in areas where this affordance is more often lacking in order to positively affect these children's development, including PA and MC[28].

In contrast to our expectations, encouraging PAPPs were not associated with the level of MC in children. This may be explained by the fact PAPPs are operationalized as parenting practices regarding PA, and not necessarily for MC[14]. We even found an initially unexpected finding in the direction of discouraging PAPPs on MC. Discouraging PAPPs are by their nature more likely to be used in situations in which children are active a priori, e.g. 'How often do you tell your child he/she can hurt him/herself when being physically active?'. This example of a discouraging PAPP item could be considered as actual discouragement of PA, but may be only relevant to use in a situation in which a child is playing in such an active manner that getting hurt may actually be a risk. This mechanism was also seen in a study examining the role of parents in facilitating outside play in young children, where the presence of parental rules regarding outside play (e.g. minimum of time spent outside or limitation of screen time) was associated with less outside play[29]. In contrast to the authors' expectations, parents may provide rules regarding outside play if they feel that this is necessary, based on the behaviour of their child, and subsequently report their child as being relatively less active[29]. Combining our findings and existing evidence of parental behaviours and the mediating pathway

through PA[30] further legitimates the need to target parental PA behaviours and children PA simultaneously in order to create synergy in children's motor development.

To our knowledge, this is one of the few studies investigating the influence of the broader ecosystem on young children's MC, with a particular focus on modifiable factors, which is considered as a major strength to reduce MC disparities during early childhood. Moreover, this study used a rather large sample of child-parent dyads and had an exceptional high response rate for the parental questionnaire (99.7% gave consent for their child to participate). However, this exploratory study used a rather rudimentary way of operationalizing children's MC into three main categories. Future studies are encouraged to increase the precision of MC measurement, for example by combining results from multiple diverse motor tasks or by differentiating between object-control, locomotor- and stability competencies. We performed sensitivity analyses to investigate whether the same explanatory variables would also explain high MC vs. low- and average MC. This showed that some previously significant variables (i.e. discouraging parenting practices, perceived availability of sports facilities and PATRns) attenuated. For gender and the presence of a garden, we found that these factors increased the odds of being classified as high MC compared to low- and average MC (Supplementary Table S2). In addition, a cross-sectional design was used, implicating that no causal pathways could be found. Longitudinal studies focusing on modifiable factors in the home and direct living environments are warranted to better understand the relationship between social-ecological influences on children's motor development. Furthermore, the exploratory character of this study was found in the inclusion of less well researched and non-validated measures, such as PAPPs and PATRns. Like many other studies focusing on the environment-behaviour relation, the explained variance was relatively limited, but the increase in explained variance in our hierarchical models indicated the added value of these measures in addition to previously studied factors, such as parental beliefs and behaviours. A limitation of the study was the lack of objective measures of the physical environment as well as the limited number of environmental characteristics included, which were included as single items. Including both objective and subjective measures on environmental characteristics could be helpful to limit the potential bias caused by parents who consider their environments to be in line with

their own perceptions concerning PA. Finally, the current study did not include PA measurements, preventing us from testing mediating associations caused by PA levels of children. Future studies are recommended to include a valid measure for long-term PA, and simultaneously study environmental factors in multiple, relevant settings to which children are exposed.

Conclusion

Characteristics of the social and physical home environment and direct living environment were associated with MC disparities during early childhood. Both parenting practices and parental PA-involved behaviours are relevant modifiable factors. Additionally, supportive actions in public spaces in neighbourhoods with a high concentration of houses with a lack of gardens could compensate for this lack. In particular, girls' MC development should be prioritised in order to prevent gender-related differences in MC (and resultant consequences) during later phases in life. Therefore, improved understanding of specific features and affordances of modifiable physical and social and environmental factors affecting girls' MC is warranted.

Practical implications

- The presence of a garden at home is associated with decreased odds of low motor competence during early childhood
- Neighbourhoods in which gardens are often lacking should be prioritised for providing supporting environmental initiatives
- Parenting practices and parental perceptions of their direct living environment are associated with children's motor competences
- Targeting parental physical activity behaviour besides children's motor competence is likely to create synergy in motor competence development
- Young girls' motor development should be better understood and prioritised in preventive initiatives.

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Tables

Table 1: Descriptive statistics for total sample and stratified per level of motor competence

	Total (N=612)		**Low MC (N=198)**		**Average MC (N=301)**		**High MC (N=113)**	
	M (SD)	N (%)	M (SD)	N (%)	M (SD)	N (%)	M (SD)	N (%)
Child demographics								
Age	5.22 (0.62)		5.21 (0.65)		5.23 (0.61)		5.19 (0.60)	
MC	2.81 (1.01)		N.A.		N.A.		N.A.	
Gender								
Boys		308 (50.3)		76 (38.4)		164 (54.5)		68 (60.2)
Girls		304 (49.7)		122 (61.6)		137 (45.5)		45 (39.8)
BMI (*n*=595)	15.37 (1.31)		15.37 (1.49)		15.36 (1.25)		15.39 (1.16)	
Underweight (IOTF)		88 (14.8%)		30 (15.5%)		39 (13.3%)		19 (17.8%)
Overweight (IOTF)		35 (5.9%)		14 (7.2%)		15 (5.1%)		6 (5.6%)
Family environment								
Siblings								
No siblings		95 (15.7)		41 (21.0)		41 (13.7)		13 (11.5)
1 sibling		361 (59.5)		112 (57.4)		178 (59.5)		71 (62.8)
2 or more siblings		151		42		80		29

	(24.9)	(21.5)	(26.8)	(25.7)
Cultural background				
	453	145	225	83
Western	(75.8)	(74.4)	(76.8)	(75.5)
	145	50	68	27
Non-Western	(24.2)	(25.6)	(23.2)	(24.5)
Parental educational level				
	18			
Low (no, primary)	(3.2)	5 (2.6)	8 (2.7)	2 (1.8)
Middle (pre-vocational – lower vocational)	170 (30.1)	54 (28.4)	81 (27.7)	35 (32.1)
High (higher vocational, university degree)	377 (66.7)	131 (68.9)	203 (69.5)	72 (66.1)
Social home environment (1-5)				
Parenting practices encouraging	3.42 (0.47)	3.40 (0.50)	3.44 (0.45)	3.39 (0.45)
Parenting practices discouraging	2.30 (0.43)	2.27 (0.44)	2.31 (0.42)	2.32 (0.40)
PATRns	2.70 (1.67)	2.56 (1.70)	2.73 (1.62)	2.85 (1.73)
Physical home environment				
Garden – active play opportunity				
	79	33	34	12
No	(12.9)	(16.7)	(11.3)	(10.6)
	43	14	23	
Yes, (almost) no space	(7.0)	(7.1)	(7.6)	6 (5.3)
Yes, limited space	182	58	92	32

	(29.7)	(29.3)	(30.6)	(28.3)
Yes, (almost) unlimited space	308 (50.3)	93 (47.0)	152 (50.5)	63 (55.8)
In home – active play opportunity				
(Almost) no space	16 (2.7)	7 (3.6)	5 (1.7)	4 (3.6)
Limited space	240 (40.3)	77 (40.1)	116 (39.6)	47 (42.3)
Almost unlimited space for active play	340 (57.0)	108 (56.3)	172 (58.7)	60 (54.1)
Physical neighbourhood (1-5)				
Availability playground	4.44 (0.93)	4.4[illegible] (0.9[illegible])	4.43 (0.98)	4.50 (0.76)
Availability sports facilities	3.84 (1.22)	3.66 (1.27)	3.91 (1.18)	3.96 (1.21)
Social neighbourhood (1-5)				
Perceived traffic safety	3.03 (1.45)	2.96 (1.43)	3.02 (1.48)	3.19 (1.41)
Perceived social safety	2.27 (1.24)	2.30 (1.24)	2.22 (1.25)	2.33 (1.23)
Perceived availability of peers	3.59 (1.32)	3.50 (1.37)	3.69 (1.27)	3.50 (1.36)

Table 2: Odds of being classified as low MC compared to average- or high MC

	Model 1		Model 2		Model 3	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Personal factors						
Gender (boys=reference)	**2.14 (1.46 – 3.13)**	**<0.01**	**2.12 (1.43-3.13)**	**<0.01**	**2.20 (1.47-3.28)**	**<0.01**
Social home environment						
Parenting practices encouraging			0.75 (0.49-1.14)	0.22	0.84 (0.54-1.30)	0.43
Parenting practices discouraging			**0.54 (0.32-0.90)**	**0.02**	**0.48 (0.28-0.83)**	**0.01**
PATRns			0.89 (0.79-1.00)	0.05	**0.79 (0.65-0.96)**	**0.03**
Physical home environment						
Garden – active play opportunity					**0.84 (0.55-1.27)**	**0.02**
Physical neighbourhood						
Availability playground					1.06 (0.82-1.38)	0.65
Availability sports facilities					**0.80 (0.66-0.96)**	**0.02**
Social neighbourhood						
Perceived traffic unsafety					0.94 (0.80-1.12)	0.54
Perceived social unsafety					1.09 (0.89-1.34)	0.39
Perceived availability of peers					0.99 (0.85-1.18)	0.98
Nagelkerke's R^2	.053		.079		.115	

Note: Only significant demographic variables are displayed in the table. All models were corrected for the covariates: age, BMI, number of siblings, cultural background, and parental educational level. All these covariates were not significant.

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Declaration of interest

The authors declare that they have no competing interests

Confirmation of ethical compliance

Ethical approval was obtained by the Ethical Research Committee of the Free University (VU) in Amsterdam, the Netherlands (VCWE-2020-137).

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