

Executive functions and self-efficacy in children with developmental dyslexia and parental attitudes of their mothers

Ewa Maria Radoń, Monika Mak, Jerzy Samochowiec

Abstract

Aim: The aim of this study was to compare executive functions and self-efficacy in children with dyslexia and/or dysorthography relative to healthy controls, as well as the intensity of parental attitudes in their mothers.

Method: Three groups of children: with developmental dyslexia and dysorthography ($n = 49$), with isolated dysorthography ($n = 51$), and without deficits ($n = 59$) underwent psychological assessment with the Stanford-Binet 5 Intelligence Scale, the Battery for diagnosing academic failure in pupils aged 10-12, the Battery for the diagnosis of cognitive performance in children aged 10-12 and the Personal Competence Scale. Their mothers completed the Parenting Attitudes Scale. Statistical analyzes were performed using IBM SPSS Statistics.

Results: Monitoring time was longer in children with dyslexia and dysorthography compared to controls. Similarly, phonological and categorical fluency was poorer among children with dyslexia and dysorthography relative to the remaining two groups. No intergroup differences were observed in terms of verbal and non-verbal working memory, monitoring correctness, planning correctness and time, or self-efficacy, strength and persistence. The excessively demanding attitude was more frequent in mothers of healthy controls compared to those of children with dyslexia and dysorthography. No significant differences were found in the intensity of the attitude of acceptance, provision of autonomy, over-protectiveness or inconsistency in the investigated mothers.

Conclusions: Due to deficits within phonological and categorical verbal fluency and a longer monitoring speed, children with dyslexia and dysorthography require stimulation within these executive domains. Among the strengths of children with developmental dyslexia and/or dysorthography are self-efficacy, strength and perseverance similar to those found in their healthy peers. Mothers of children with comorbid dyslexia and dysorthography manifest a lesser tendency to an excessively demanding attitude compared to mothers of healthy children.

developmental dyslexia; dysorthography; executive functions; self-efficacy, parental attitudes

INTRODUCTION

As one of neurodevelopmental disorders, developmental dyslexia is currently considered a civilization problem. According to the International Dyslexia Association, it is a learning disability affecting reading and writing comprehension,

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resulting from a basic deficit within phonological processing [1]. Its main symptoms include incorrect and/or slow recognition of written words and impaired writing skills, which affect reading fluency and understanding, as well as written expression. All these problems may exist in relative isolation or coincide. Research on the causes underlying the disorder suggest their polyethiology [2]. To date, executive function deficits have not been considered an axial symptom of dyslexia, although some researchers recognize their role in its pathomechanism [3]. Exploration of various components of executive performance in children with learning disabilities is gaining prominence, especially regarding those diagnosed with developmental dyslexia. They are students with special learning needs, for whom the ability to act in a planned manner (controlled largely by executive functions) seems particularly important.

Another significant contributor in the development of a child with dyslexia is their family environment. In families of dyslexic children, there may be inconsistencies between the ideal and real functioning thereof, fostering the formation of negative attitudes in their parents. When a child does not meet parental expectations, an attitude of indifference, inconsistency, rejection or non-acceptance may emerge in the caregivers. Moreover, children diagnosed with dyslexia are more likely to be exposed to excessive demands and pressure from the family environment in order to increase their involvement in eliminating learning difficulties [4]. Their educational failures may also trigger negative behaviors in the form of excessive strictness, criticism, repeated admonitions, shouting, ridicule or punishment [5]. Other parents may, in turn, become overly protective or overly focused on the child's academic problems. In consequence, they may excessively control their offspring's actions or help them out. Such frequent taking over of responsibility for school tasks by parents may have negative outcomes in their children, in the form of tendencies to withdraw from activity or manifest reduced sense of competence or self-worth.

Therefore, it seems worthwhile to also monitor the level of self-efficacy in children with developmental dyslexia, as their individual beliefs concerning the ability to control their activ-

ity in achieving set goals may significantly affect the education process. Given that self-efficacy is mainly construed based on previous achievements or lack thereof, pupils with developmental dyslexia are very likely to form unfavorable beliefs about their poor educational competences [6]. An extensive meta-analysis comparing 61 studies revealed children with dyslexia to manifest reduced sense of competence in terms of school achievement [7]. As for adolescents with learning disabilities, reduced self-efficacy has been found in both foreign and Polish studies [8,9,10]. Polish pupils with dyslexia demonstrated lower level of generalized self-efficacy, lesser power to engage in activities and less persistence in striving for success relative to controls. Compared to their peers, they also reported poorer motivation to take up challenges, expected failure more frequently and were more likely to respond with resignation in task-related situations.

AIM

The main aim of this study was to compare executive functions and self-efficacy in children with dyslexia and/or dysorthography relative to healthy controls, as well as the intensity of parental attitudes in their mothers.

MATERIAL AND METHODS

The study included 159 children from the West Pomeranian Voivodeship and their mothers. Sample size was determined based on the following parameters: medium effect size ($f = 0.25$), $\alpha = 0.05$, test power = 0.8, number of groups: 3. Upon purposeful selection, all of the participants provided voluntary and informed consent to participate in the study. This research protocol was approved by the Bioethics Committee of the Pomeranian Medical University in Szczecin.

The sample was divided into three groups: with the diagnosis of dyslexia and dysorthography ($n = 49$), with the diagnosis of isolated dysorthography ($n = 51$), and a control group including children without any developmental deficits ($n = 59$). No significant differences were found between groups in terms of age or IQ lev-

el. The mean age of children with dyslexia and dysorthography was 136.93 months ($SD = 8.47$), children with isolated dysorthography – 139.45 months ($SD = 9.13$), and healthy controls – 139.32 months ($SD = 10.52$). The inclusion criteria to the clinical groups were: age from 10 to 12 years; diagnosis of dyslexia and dysorthography or isolated dysorthography based on a full psychological and pedagogical assessment and ICD-10 criteria; grade IV, V or VI student status; average level of intelligence; and consent to participate in the study. The exclusion criteria were: visual and/or hearing impairment; the presence of neurological or psychiatric disorders; and being brought up in a foster or adoptive family. The inclusion criteria to the control group were similar, except for the diagnosis of neurodevelopmental disorders, as the controls had to demonstrate at least average literacy skills. Male gender dominated in all three groups: boys constituted 69.4% of the group diagnosed with dyslexia and dysorthography, 62.7% of the group diagnosed with isolated dysorthography, and 61% of the control group. Children with dyslexia and dysorthography and controls resided mainly in urban areas (53.1% and 64.4%, respectively), whereas those with isolated dysorthography came mainly from rural environments (51%). The mothers of children with dyslexia and dysorthography were aged 28 to 52 years ($M = 38.98$; $SD = 5.24$), the mothers of children with isolated dysorthography 33 to 49 years ($M = 40.18$; $SD = 4.04$), and the mothers of controls 31 to 51 years ($M = 39.37$; $SD = 4.20$).

Assessment consisted of two to three meetings lasting between 40 and 80 minutes and was based on the use of a set of standardized tools with good validity and reliability indices. The verbal and non-verbal working memory were tested with *The Stanford-Binet 5 Intelligence Scale* by Roid et al., created for the assessment of intelligence and cognitive abilities in the population and special groups [11]. The diagnosis of dyslexia and/or dysorthography was based on the *Battery for the diagnosis of the causes underlying school failure in pupils aged 10-12* created by Bogdanowicz et al., including tests of functions, processes and abilities necessary for the efficient reading and writing skills (ie. visual-spatial, auditory-linguistic and perceptual-motor integration) [12]. Three tests included in the *Battery for*

the diagnosis of cognitive functions in children aged 10-12 PU-1 by Borkowska et al. were used to assess executive performance. These were: a computer-assisted version of the *Ridiculousness Test*, measuring the ability to monitor representation; *the Phonological and Categorical Verbal Fluency Test*, assessing verbal fluency; and *the Map of the Park Test*, measuring planning ability and cognitive control [13]. The level of self-efficacy was assessed with the self-report *KompOs – Personal Competence Scale* by Juczyński, a tool measuring one's general beliefs concerning their ability to act effectively and persistently. The scale also measures beliefs about one's strength to initiate an action and the perseverance to carry it on. It contains 12 items rated on a 4-point scale [14]. To determine parental attitudes in the mothers, the 50-item *Parental Attitude Scale* by Plopa was used, corresponding to five dimensions of parental attitudes: acceptance-rejection, excessive demands, autonomy, inconsistency and overprotectiveness. The statements are rated on a 5-point scale [15]. The research procedure also included documentation analysis and developmental interview. Statistical analyzes were performed using IBM SPSS Statistics 26.0. Basic descriptive statistics and the normality of distribution were calculated with the Shapiro-Wilk test. Inter-group comparisons were performed using a one-way analysis of variance. Statistical significance was set at $\alpha = 0.05$. Most of the variables had normal distribution. Welch's correction was applied when the variances in the compared groups were not homogeneous. The post hoc Bonferroni test was performed for the homogeneous and the Games-Howell test for the heterogeneous variances.

RESULTS

As regards the efficiency of executive functions, significant differences were observed in terms of verbal working memory, monitoring correctness and time, as well as phonological and categorical fluency. Post hoc analysis showed longer monitoring time in children with dyslexia and dysorthography compared to controls ($p = 0.046$). Phonological fluency was poorer among children with dyslexia and dysorthography compared to controls ($p = 0.001$) and chil-

dren with isolated dysorthography ($p = 0.006$). Similarly, categorical fluency was poorer in children with dyslexia and dysorthography than in controls ($p < 0.001$) and those with isolated dysorthography ($p < 0.001$). After adjusting for multiple comparisons, the inter-group

differences in monitoring accuracy and verbal working memory turned out insignificant ($p > 0.05$). Similarly, no significant differences were found in terms of non-verbal working memory or planning accuracy and time. All results are presented in Table 1.

Table 1. Inter-group comparisons in terms of the efficiency of executive functions

	Control group (n = 59)		Isolated dysorthography (n = 51)		Dyslexia and dysorthography (n = 49)		F	p	η^2
	M	SD	M	SD	M	SD			
Non-verbal working memory	19.69	2.47	19.75	2.61	19.14	1.95	1.01	0.368	0.01
Verbal working memory	19.46	1.49	19.49	1.16	18.80	1.78	3.49	0.032	0.04
Monitoring	38.39	1.22	37.86	1.47	37.76	1.45	3.37	0.036	0.04
Monitoring time	92.37	23.46	93.61	21.72	103.27	23.64	3.46	0.033	0.04
Phonological fluency (letter K)	12.68	3.74	12.37	3.06	10.18	3.62	7.77	<0.001	0.09
Categorical fluency (animals)	20.17	5.37	19.41	3.76	16.53	3.46	12.12 ^a	<0.001	0.11
Planning	5.10	1.27	5.57	1.32	5.41	1.31	1.86	0.159	0.02
Planning time	0.159	52.37	83.47	50.87	71.82	26.77	0.98	0.378	0.01

^aWelch's correction was applied

No significant differences were found in terms of self-efficacy, strength or perseverance. This means that all children displayed similar levels

of self-efficacy and its two dimensions. The results are presented in Table 2.

Table 2. Inter-group comparisons in terms of self-efficacy

	Control group (n = 59)		Isolated dysorthography (n = 51)		Dyslexia and dysorthography (n = 49)		F	p	η^2
	M	SD	M	SD	M	SD			
Self-efficacy	33.32	6.56	34.29	4.90	34.78	4.67	0.90 ^a	0.411	0.01
Strength (dimension)	16.73	3.62	17.18	2.98	17.82	3.56	1.36	0.259	0.02
Perseverance (dimension)	16.56	3.78	17.10	3.23	17.14	2.46	0.50 ^a	0.606	0.01

^aWelch's correction was applied

As for maternal attitudes, significant differences were found in terms of the intensity of the demanding attitude. Detailed post hoc analysis showed its higher values in the mothers of controls compared to the mothers of children with

dyslexia and dysorthography ($p = 0.041$). No other significant differences were found in the investigated sample. The results are presented in Table 3.

Table 3. Inter-group comparisons in terms of maternal attitudes

Maternal attitude	Control group (n = 59)		Isolated dysorthography (n = 51)		Dyslexia and dysorthography (n = 49)		F	p	η^2
	M	SD	M	SD	M	SD			
Accepting	43.85	5.01	44.71	3.94	43.51	4.56	0.93	0.397	0.01
Autonomy	37.76	3.88	37.78	4.60	36.57	4.49	1.32	0.271	0.02
Protective	28.27	7.95	28.51	6.90	25.37	7.75	2.70	0.070	0.03
Demanding	28.78	7.30	27.43	6.16	25.49	6.90	–	3.16	25.49
Inconsistent	23.71	7.72	22.59	7.66	21.10	6.75	1.66	0.193	0.02

DISCUSSION

Several differences emerged in the executive performance of children with dyslexia and dysorthography relative to the controls without learning disabilities. One of the discrepancies concerned monitoring speed, found to be longer in the former group. Interestingly, children with isolated dysorthography demonstrated similar performance to their healthy counterparts, both in terms of speed and correctness of monitoring. Children with dyslexia and dysorthography are therefore likely to require more time to achieve outcomes similar to their healthy peers when performing monitoring tasks involving detection of nonsense and illogicality. This is consistent with the results of Reiter et al., who found children with developmental dyslexia to need more time to process information [3]. Moreover, there is also evidence of executive deficits in the form of poorer processing speed and slower reaction time in adolescents with dyslexia [16]. Our findings suggest that when spelling disorders co-occur with difficulties concerning reading correctness and pace, it translates to poorer executive performance in the form of a lower monitoring speed, although the level of correctness remains intact (ie. is similar to that of healthy controls). However, some reports yield contradictory results, suggesting that children diagnosed with developmental dyslexia may also manifest dysfunctions within their capacity to monitor mistakes and solve problems [17]. Nevertheless, the observed inconsistencies may be partially accounted for by the use of different diagnostic tools.

Children with dyslexia and dysorthography presented poorer verbal fluency compared to

children from the control group and those with isolated dysorthography. Given the dominant role of executive processes in verbal expression, it should be noted that children with dyslexia and dysorthography manifest poorer executive functioning responsible for selection of a memory search strategy, control of the task progress and maintaining compliance with the imposed criterion. Children with isolated dysorthography showed a similar level of verbal fluency (both phonological and categorical) to children without deficits, which suggests they may possess more effective resource searching strategies, alongside a greater capacity to maintain them, and, if necessary, flexibly change between them compared to children with dyslexia and dysorthography. Limited access to the resources of semantic memory and the phonological lexicon in children with dyslexia and dysorthography has been described in other studies [3, 18, 19, 20, 21]. Of note, poorer phonological and categorical fluency in this clinical group may partially result not only from the reduced capacity to generate words in particular subcategories, but also from a reduced processing speed, as it is known that the utterance of a sentence requires a limited temporal frame. Given the longer monitoring time recorded in this group, it seems likely that the speed of certain cognitive functions and information processing may be lesser in children with dyslexia and dysorthography. The results of this study also suggest that children with co-occurring dyslexia and dysorthography exhibit poorer executive performance in linguistic tasks, which is consistent with the commonly accepted finding that the underlying mechanism of this disorder are deficits in phonological processing [21, 22, 23, 24]. They are also partially

consistent with the double deficit theory, which, apart from the impaired phonological processing, highlights deficits within information processing and naming speed in developmental dyslexia – emphasizing the impact of slow processing on reading fluency. It thus seems valid to consider including slow processing speed and reduced verbal fluency in the scope of executive dysfunctions present in the clinical picture of dyslexia [25, 26]. Therefore, the assessment of children who are at risk of developing dyslexia and dysorthography should be extended to test for verbal fluency, both phonological and criterion-related, as well as to assess monitoring speed. In addition, therapeutic programs supporting cognitive functioning of children in at-risk groups should include training of these skills. Strengthening of resources related to strategies responsible for achieving set goals, an efficient speed of monitoring performed activities or flexible behavioral adaptation could offer tangible benefits.

All examined groups showed similar cognitive efficiency in terms of verbal and non-verbal working memory, reaction time and correctness, and correctness of monitoring. Such lack of significant differences within the above skills across the children with and without learning disabilities suggests that they are likely to constitute important resources which could lay the ground for compensatory interventions. A similar level of development of the memory processes via which various types of information (verbal and visual) placed in short-term memory are checked, grouped and transformed, should be conducive to effective mental work on various educational tasks and challenges. It is of note, however, that maintaining similar abilities as properly developing peers in terms of storing, processing and extracting information (especially verbal) in/from short-term memory is a finding that is rarely described in previous research [27]. There is a large body of evidence reporting dysfunctions within both verbal and non-verbal working memory in this clinical group [3, 16, 28, 29]. Such discrepancy apparent in this study may be partly due to the lack of random selection of participants to the control group and inclusion of only those children whose parents provided their consent. Another factor could be the low age of children, as due to the dynam-

ics of the development of executive functions, a greater discrepancy in the results between children from clinical and healthy groups can be expected as they grow older. Therefore, in the future, it would be worthwhile to conduct longitudinal studies comparing the efficiency of verbal working memory also in older children and adolescents with developmental dyslexia. Last but not least, found differences may be due to the use of different testing tools. Meta-analyses suggest that although the occurrence of executive problems is frequent among children with developmental dyslexia, the results of individual research may largely depend on how executive functions are defined and tested [28]. Interestingly, some authors also failed to observe reduced performance of tasks involving the visual-spatial working memory in children with developmental dyslexia [22, 30], while the reported differences relative to the control group existed only in the performance of verbal tasks [18]. Dyslexic individuals scored significantly lower in tasks involving repetition of series of numbers and words or pseudo-words, although they did not manifest significant differences in tasks related to reconstructing the location of points on a plane, geometric patterns or the order of presented sequences from memory. Hence, problems seemed to have occurred whenever working memory was used to perform linguistic tasks involving phonological loop, but not those of a visual-spatial nature [21, 22]. This suggests that research on verbal and non-verbal working memory skills in this clinical group should be continued.

This study showed that relative to controls, children with dyslexia and dysorthography and isolated dysorthography showed similar executive performance in terms of reaction planning. This pertains to both the processing speed and the effectiveness of cognitive control in accordance with the provided criterion. Similar performance can be interpreted as a resource thanks to which these children can predict and design subsequent stages of their activities, also as regards their education, as effectively as their healthy peers. As per educational requirements, the activity of planning, involving both working memory and inhibition processes, seems to be extremely useful as it allows pupils to manage their actions in a planned and intentional

manner. According to this study results, children with dyslexia and/or dysorthography are equally capable of setting and pursuing goals according to a previously ordered sequence as their peers without learning disorders, which corroborates previous findings [19].

In the course of the analyzes, children with dyslexia and/or dysorthography turned out to show a similar level of self-efficacy and its two dimensions: strength and persistence as their peers from the control group. This shows that despite the academic difficulties in reading and/or writing, children from the clinical groups manifest a similar sense of personal competence and similar capacity to initiate and continue actions as their healthy counterparts. Self-efficacy may therefore be construed as their important resource, which, if skilfully taken advantage of by specialists, can be a valuable factor compensating for learning problems. It will also help them treat any encountered difficulties in terms of a challenge, which bodes well for the potential therapeutic interventions. Hence, children with dyslexia and/or dysorthography are likely to be as successful in engaging in the intended activities as their peers, which was also found in previous studies [31, 32]. There is, however, also contrary evidence. Kowaluk – Romanek [9] and Gindrich [10] unanimously reported adolescents with dyslexia to demonstrate a lower level of generalized self-efficacy and less persistence in striving for success. Several factors may be responsible for these discrepancies. First, the children participating in this study were young enough for their capacity for self-awareness, insight, and reliable self-esteem to be limited. It is also very likely that the age-related immaturity of objective self-assessment and the presence of a psychologist triggered a particular willingness to generate a more positive self-presentation and respond in line with the assumed social expectations. Third, due to the short time from diagnosis, the participants may not have experienced too many deficits yet, which would otherwise translate into reporting a lower sense of self-efficacy. Perhaps such a problem will appear in the future, when learning difficulties accumulate, and both a tendency to engage in self-criticism and insight increase. The last factor that may have affected the observed lack of intergroup differences in the sense of self-effi-

cacy is the fact that even prior to diagnosis, pupils with dyslexia and/or dysorthography had been attending remedial or correctional classes, whose effect was not intended as strictly therapeutic, but which could indirectly fulfill such a function. According to Łodygowska [33], the sense of self-efficacy is related to the therapeutic experiences of dyslexic children, and pupils provided with systematic and specialist assistance show a stronger sense of self-efficacy, strength and perseverance, compared to those who have not experienced this type of support. Therefore, it cannot be ruled out that these initial interventions had a positive effect on the sense of self-efficacy of children diagnosed with dyslexia and/or dysorthography, thus mitigating the differences between them and controls. Therefore, this warrants the use of ad hoc preventive actions aimed at maintaining the desired sense of personal competence, strength to initiate actions and perseverance to carry them out in the future. It may be particularly important in the later stages of education, where problems resulting from dyslexic and/or dysorthographic deficits may accumulate and deteriorate, thus contributing to the risk of undermining the sense of self-efficacy in children.

The repertoire of parental attitudes of mothers of children with dyslexia and dysorthography and isolated dysorthography showed many similarities to the attitudes of mothers of healthy children. That is, all investigated children experienced a similar level of acceptance, autonomy, protection and inconsistency on the part of their mothers. The only difference involved a lesser tendency to exhibit excessive demands observed in the mothers of children with concomitant dyslexia and dysorthography relative to the mothers of controls. This means that they are less strict and more accepting of their children's failures, criticism or objections. They are more lenient when it comes to assessing their children's performance and more likely to take into account their natural abilities. Such an attitude serves as a protective factor especially in the case of children with the greatest deficits, shielding them from exaggerated expectations and excessive pressure. Interestingly, a similar attitude of reduced requirements was not observed in the mothers of children with isolated dysorthography. This may be due to the

lower number of concerning symptoms (which are mainly limited to the activity of writing) in this group of children, which in turn does not prompt the mothers to significantly lower their expectations. Therefore, psychoeducational programs should be offered to mothers of children from this clinical group, with an aim to modify their attitudes to e.g. lessen their expectations. The development of such parenting guidelines should make the mothers of these children aware that isolated writing disorders also require a special parental approach, which should not include the same expectations and requirements that are placed on children without neurodevelopmental disorders. These results reveal that, contrary to initial expectations, the mothers of children with dyslexia and/or dysorthography are no less accepting, no more demanding, protective, inconsistent or providing less autonomy to their offspring than the mothers of healthy children. This study did not find children diagnosed with developmental dyslexia to be more exposed to criticism, excessive pressure and unrealistic demands from their mothers [4,5]. Nevertheless, previous reports show that parents of dyslexic children do tend to present their attitudes towards their offspring in a much more favorable light [15]. Therefore, future research could be extended to include collateral reports from the children and the other parent alongside the self-reported data from only one caregiver.

To conclude, future research endeavors should include longitudinal studies monitoring possible changes in the executive performance and the level of self-efficacy in children with dyslexia in the course of further development. Moreover, it is advised that the methodology of subsequent tests include more diverse diagnostic tools available on the market. To increase the value of future comparisons, they should be extended to also include paternal attitudes and collateral reports of parental attitudes by children.

CONCLUSIONS

1. Phonological and categorical verbal fluency and monitoring speed were reduced in children with concomitant diagnosis of dyslexia and dysorthography relative to healthy controls. This warrants implementation of interventions to improve the above-mentioned executive functions in this population.
2. Among the strengths of children with dyslexia and dysorthography, as well as isolated dysorthography, is the functioning of their verbal and non-verbal working memory, speed and correctness of reaction planning, and correctness of monitoring, on a similar level to that of controls. These are the cognitive resources that may favor the design of compensatory interventions for the remaining deficits.
3. Compared to their healthy peers, children with dyslexia and/or dysorthography do not show a lower level of self-efficacy or its two dimensions: strength and persistence. A similar sense of personal competence in all children is a good foundation for corrective work with pupils from the clinical groups.
4. Children from all investigated groups experience similar levels of motherly acceptance, provided autonomy, protection and inconsistency. The mothers of children with dyslexia and dysorthography reported lesser attitudes of excessive demands compared to the mothers of healthy children. This protects the children with the highest levels of deficits from exaggerated expectations and undue pressure. However, a similar phenomenon was not observed in mothers of children with isolated dysorthography, whose expectations are close to those of mothers of healthy children. They should, therefore, be offered support in the form of psychoeducation, which could make them aware of the benefits of adopting a less demanding attitude towards their children.

LIMITATIONS

These study limitations include the fact that it was partially carried out during the Covid-19 pandemic, potentially affecting the external validity and disrupting the research process, which had to be temporarily suspended due to the introduced restrictions. Due to the closure of schools and the transition to remote learning, the originally assumed random selection of participants to the control group was also abandoned.

Therefore, the conclusions of this study cannot be generalized to the general population.

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