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Cohort Profile

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Cohort Profile Update: The TRacking Adolescents' Individual Lives Survey—The Next Generation (TRAILS NEXT)

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Key Features

- TRAILS—The Next Generation (TRAILS NEXT) is an intergenerational spin-off originating from the TRacking Adolescents' Individual Lives Survey (TRAILS) which has followed 2772 Dutch adolescents since age 11, and has run parallel to TRAILS since 2015.
- TRAILS NEXT investigates if and how preconception development that spans adolescence and young adulthood influences the next generation's development.
- TRAILS NEXT currently includes 368 TRAILS respondents of whom 263 have firstborn children, 149 have second-born children, 23 have third-born children and three have fourth-born children.
- Parents complete weekly online measurements during pregnancy and until 3 months after birth, which are followed by home visits at 3 months, 2.5 years and 4.5 years after birth (and is planned to continue, if funding permits).
- TRAILS NEXT is open to collaborations with other researchers, and access to the data can be obtained by submitting a publication proposal obtainable at [https://www.trails.nl/en] to the corresponding author at [c.a.hartman@umcg.nl]

The original cohort

The TRacking Adolescents' Individual Lives Survey (TRAILS) has followed pre-adolescents from ~11 years onwards to investigate determinants of mental health and social development during adolescence and young adulthood. TRAILS consists of a population and a high-risk sample: the TRAILS population sample ($n = 2229$) was set up in 2001 and recruitment took place via primary schools in the north of The Netherlands. The population sample was complemented by a sample selected based on contact with child and adolescent mental health services before age 11. This 'high-risk sample' was set up in 2004 ($n = 543$). In both samples, follow-up data collection occurs at intervals of 2–3 years but the high-risk sample lags behind the population sample by approximately one assessment wave. Seven waves have been completed for the population sample, six waves have been

completed for the high-risk sample. When the most recent cohort profile update was published in 2015, data collection focused on completion of education and entrance into the labour market. Romantic partners were included as informants.[1] TRAILS NEXT is an intergenerational spin-off originating from TRAILS and runs parallel to but independent from the original cohort. Participants are recruited as they or their partner become pregnant, as determined by regular mailings.

What is the reason for the new focus and data collection?

TRAILS participants have reached the age at which family formation is common, which sparked the set-up of the intergenerational cohort. Prospective intergenerational cohorts are rare, yet parental development and experiences prior to parenthood are increasingly emphasized to contribute to offspring development.[2,3] To elucidate preconception influence on offspring, we have developed assessment protocols for different ages which incorporate observations of both parents in interaction with the child, interviews with both parents, questionnaires completed by both parents and by the child's teacher, experimental tasks with the child and a puppet interview with the child. The multiple perspectives and modes of assessment make TRAILS NEXT unique in its wealth of information and extremely well suited for prospective research on intergenerational transmission of health and disease.

What are the new areas of research?

A few existing intergenerational studies illustrate the novel topics that can also be addressed with TRAILS NEXT, including long-term links between adolescent mental health and psychopathology in early parenthood as well as offspring development.[4–6] As these studies demonstrate, parental developmental histories affect child outcomes, and TRAILS NEXT allows for zooming in on potential mechanisms that explain such links. Particular attention is paid to capturing these mechanisms in detail, such as parenting, which is assessed in interviews, questionnaires and through observations of parent-child interactions. Information about both parents' mental health, their relationship, household characteristics and social support network is collected at multiple time points throughout early childhood, and complemented by experiments and a puppet interview with children and reports from pre-school teachers. Zooming in on such microlevels provides the information that is needed to understand environmental pathways of continuity of health and disease, and of psychological and social problems, across generations.

Importantly, children are not only exposed to the environment their parents create but also inherit their genes. Children-of-twins studies support the notion that intergenerational transmission of traits and behaviours results from a complex gene-environment interplay.[7] Genotypic information allows for examining these mechanisms in non-twin samples, yet hardly any rigorous tests of genetic transmission effects have been published, likely because studies with genotypic information from parents and children and comprehensive environmental assessments are still rare. TRAILS NEXT fills this gap and uses recent progress in genome-wide association studies that have identified robust genetic variants involved in psychological, psychiatric and social outcomes including educational attainment,[8] depression[9] and attention-deficit hyperactivity disorder (ADHD),[10] using polygenic scores to examine parental effects on child outcomes.[11,12] Offspring and parents are genotyped in TRAILS NEXT, which allows us to test gene-environment correlations that may explain parent-child effects rigorously. Of particular interest are tests of 'genetic nurture' to disentangle genetic from environmental causation by examining the extent to which non-inherited genes affect offspring outcomes via environments created by parents.[13,14] The combination of genetic data and environmental information that is both in-depth and broad opens a treasure trove for developmental research.

Who is in the cohort?

Since 2015 and ongoing, TRAILS NEXT runs parallel to TRAILS and is open to any TRAILS participant who becomes a parent. To identify potential TRAILS NEXT participants, e-mails are sent out to TRAILS participants four times per year enquiring after a possible (partner's) pregnancy. Affirming TRAILS participants are invited to participate in TRAILS NEXT and indicate their interest by clicking a link that is provided in the e-mail. Research assistants contact the potential participants, distribute information and eventually carry out home visits (see Figure 1). TRAILS NEXT families enter the study during pregnancy (measurement time 1, T1) and are visited by research assistants at 3 months (measurement time 2, T2), 2.5 years (measurement time 3, T3) and 4.5 years (measurement time 4, T4) of offspring age.

Of those who affirmed an ongoing pregnancy following the e-mail enquiry, approximately 10% actively declined participation, had a miscarriage or could not be reached despite their initial affirmation of being pregnant. As such, TRAILS NEXT participants are recruited from the TRAILS sample and enter TRAILS NEXT in a staggered manner when a pregnancy becomes known. Sometimes TRAILS participants miss our e-mails initially and enter TRAILS NEXT after pregnancy, which means that not for all participants are data

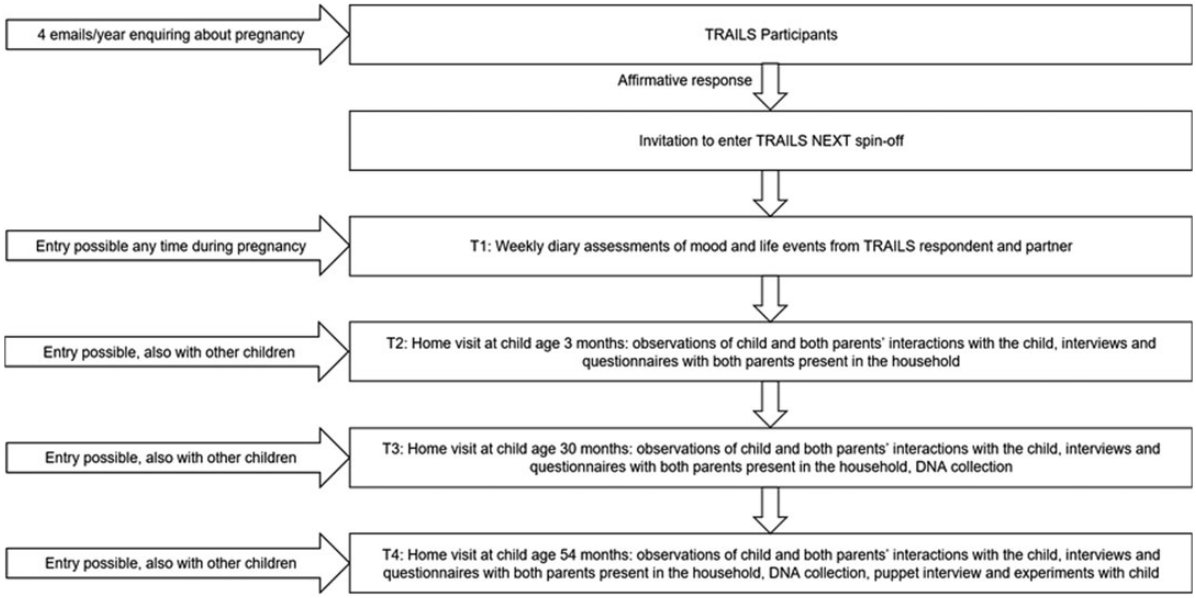

Figure 1 Flowchart depicting recruitment into TRAILS NEXT and content of assessment waves. TRAILS NEXT = the TRacking Adolescents' Individual Lives Survey: the next generation. At time of writing (June 2021), $n = 368$ TRAILS participants had given an affirming response to the e-mail contact enquiring about a pregnancy. T1 = Wave 1 TRAILS-NEXT, T2 = Wave 2 TRAILS-NEXT, T3 = Wave 3 TRAILS-NEXT, T4 = Wave 4 TRAILS-NEXT. We have conducted 283 T2 home visits, 141 T3 home visits, and 18 T4 home visits. Some 'home visits' had to be conducted via the telephone (T1: 50, T2: 16, T3: 10) to account for restrictions pertaining to the Covid-19 pandemic or when participants live abroad

available for all TRAILS NEXT measurement waves. Alongside the 'target parent' (i.e. the parent who also participates in TRAILS), the other biological parent is invited into TRAILS NEXT, and—where relevant—non-biological parents who play a significant role in the child's upbringing. In cases where the relationship between biological parents breaks down before the baby is born, we do not follow up with the biological parent. If the relationship breaks down after the birth, the later assessment waves are conducted with the biological parent that is not the TRAILS participant but only if there is no risk that inclusion jeopardizes continued participation of the TRAILS parent. 'Social parents'. i.e. new partners who live together with the TRAILS participant, are also invited to join TRAILS NEXT.

At the time of writing (June 2021), $n = 368$ TRAILS respondents (74% female) have entered TRAILS NEXT, with a total of 436 children of whom $n = 263$ are firstborn, $n = 147$ second-born, $n = 23$ third-born and three fourth-born. In other words, many TRAILS respondents enter with more than one child, some TRAILS respondents enter during their second or third pregnancy and $n = 98$ pregnancies are ongoing. Even though all TRAILS participants are roughly of the same age (population cohort: born around 1990/1991; high-risk cohort: born around 1993/1994), they have children at different ages. That said, TRAILS participants were on average 28 years old when entering TRAILS NEXT with their first child, though note that due to only starting TRAILS NEXT when TRAILS participants were already in their early-to-mid-20s, this does not reflect age at first birth.

We compared TRAILS participants who entered TRAILS NEXT with those who reported having had a child between TRAILS assessment Waves 4 (age ~19) and 7 (age ~29) but who did not enter TRAILS NEXT ($n = 174$), on a range of measures that might be associated with the age at which someone becomes a parent: (i) gender; (ii) ethnicity of TRAILS participants' parents, which was conceptualized as at least one parent born in Surinam, Dutch Antilles, Indonesia, Morocco, Turkey or another, non-Western country; (iii) family-of-origin socioeconomic status (SES) which was calculated as factor score based on TRAILS participants' parents' education, occupation and family income, with a mean of 0 and higher scores representing higher SES; and (iv) TRAILS participants' intelligence quotient (IQ) at age 11. IQ was assessed using the Revised Wechsler Intelligence Scales (WISC-R). Full-scale IQ was estimated from the two subscales that showed the highest correlation ($r = 0.90$), specifically the vocabulary subscale which reflects verbal abilities and the block design subscale which reflects spatial abilities[15,16] (Table 1).

We also compared TRAILS NEXT participants with TRAILS participants who between TRAILS Waves 4 and 7 indicated not having had a child ($n = 615$). Note that the last group contains only those TRAILS participants who at each wave answered negatively to the question whether they or their partner had a child; we ignored cases for whom missing data did not allow for certain classification. TRAILS NEXT participants come from families with higher socioeconomic status, scored higher on IQ in early

Table 1 Demographic information on TRAILS NEXT participants in comparison with TRAILS parents not in TRAILS NEXT and TRAILS participants who do not have children

	TRAILS NEXT sample[a] ($n = 368$)	TRAILS parents not in TRAILS NEXT ($n = 174$)	Comparison	TRAILS participants without children ($n = 615$)	Comparison
Female	272 (74%)	120 (69%)	$\chi^2 = 1.44$, $P = 0.229$	364 (59%)	$\chi^2 = 21.86$, $P < 0.001$
Both parents of Western ethnicity	354 (94%)	160 (92%)	$\chi^2 = 0.56$, $P = 0.439$	578 (94%)	$\chi^2 = 0.02$, $P = 0.882$
Family-of-origin SES	0.03 (0.77)	−0.35 (0.73)	$t = 5.41$, $P < 0.001$	0.25 (0.74)	$t = -4.39$, $P < .001$
Educational attainment at TRAILS T6/T7	4.53 (1.43)	3.75 (1.38)	$t = 4.91$, $P < 0.001$	4.74 (1.34)	$t = -2.26$, $P = 0.024$
Cognitive abilities at TRAILS T1					
WISC: Full scale deviation quotient	98.70 (14.20)	92.07 (12.98)	$t = 5.21$, $P < 0.001$	102.95 (14.25)	$t = -4.53$, $P < 0.001$
WISC: Vocabulary (normalized standard subtest score)	9.24 (2.69)	8.11 (2.34)	$t = 4.75$, $P < 0.001$	10.07 (2.82)	$t = -4.49$, $P < 0 .001$
WISC: Block design (normalized standard subtest score)	10.34 (2.92)	9.25 (2.91)	$t = 4.07$, $P < 0.001$	10.92 (2.97)	$t = -2.97$, $P < .001$

Notes: TRAILS-NEXT = the TRacking Adolescents' Individual Lives Survey: the next generation. TRAILS = The TRacking Adolescents' Individual Lives Survey (TRAILS). Two-tailed t tests were conducted for continuous data, χ^2 tests were conducted for categorical data. Non-Western ethnicity of family of origin indicates that at least one parent was born in Surinam, Dutch Antilles, Indonesia, Morocco, Turkey or another less frequently named country. Family-of-origin socioeconomic status (SES) was calculated as factor score based on both parents' educational attainment, occupations and family income. Educational attainment was coded on a scale from 1 (none beyond primary school) to 7 (university education), reflecting the levels of Dutch secondary and tertiary education. T6/T7: wave 6 (high-risk cohort) and wave 7 (population cohort) of TRAILS. Cognitive abilities of TRAILS respondents were assessed using the Revised Wechsler Intelligence Scales (WISC). The Full-scale deviation quotient was estimated from vocabulary and block design tasks which tap into verbal and spatial abilities, respectively. The subscales are scored on a range from 1 to 19 (verbal) and 1 to 18 (spatial) and subsequently combined to calculate the deviation quotient as suggested in the original source of the test.[15–17] T1: Wave 1 of TRAILS. Data were not complete for all demographic indicators, *n*'s in column heads refer to baseline groups.

[a]The *n* refers to the number of TRAILS participants who were recruited into the TRAILS NEXT study. They participate in TRAILS with one or more children.

adolescence and had higher educational attainment than TRAILS participants with children who did not enter TRAILS NEXT. Compared with TRAILS participants without children, TRAILS NEXT participants scored lower on family-of-origin SES, educational attainment, and cognitive abilities as assessed in their own childhood, and were more often female. Overall, the differences likely reflect later age at first birth among men and young adults from families of higher socioeconomic status and educational attainment as well as selection bias disfavouring those who score lower on these indicators.

Data collection continues at least until 500 offspring have been included and as long as funding permits thereafter, including measurement beyond age 4.5 years.

What has been measured?

To capture the full range of environmental influence on child development, questionnaires, interviews, observations, evaluations of home conditions, and physical activity monitoring are used, next to use of heel blood in the first week after birth and collection of buccal cells at 2.5 years for genotyping. Table 2 lists all instruments used in TRAILS NEXT as well as the ages at which they are collected.

Parents

During pregnancy and up to 3 months postpartum, we collect weekly measures of parental positive and negative affect and life-events from both parents (T1); detailed pregnancy information is additionally collected during a home visit interview with the mother when the child is 3 months old (T2). Parenting and parental stress, self-efficacy, personality, life-events and parental psychopathology are assessed at T2 to T4. Buccal cells for genotyping are collected from both parents at T3.

Children

At T2, T3 and T4, we collect information on offspring temperament, sleep, crying, medical history, (early precursors of) executive functioning, social competence development, mental health and disease and functioning/impairment, using interviews with parents and questionnaires. At T2, we additionally record early motor development. At T3, self-control and social communication tasks are administered. At T4, puppet interviews are conducted to collect child-perspective data on relationships with parents and peers and internalizing and externalizing problems; and the child's teacher is asked to provide information on psychopathology, social competence and the

Table 2 Instruments used in TRAILS NEXT

Construct	Instrument	Weekly during pregnancy	Weekly during first 12 weeks postnatal	T2 (3 months)	T3 (2.5 years)	T4 (4.5 years)
About the child						
Temperament/behavioural control	Infant Behaviour Questionnaire[18]			P		
	Early Childhood Behaviour Questionnaire[19]				P	
	Child Behaviour Questionnaire[20]					P
Social competence	Infant–Toddler Social and Emotional Assessment[21]				P	
	Strengths and Difficulties Questionnaire[22,23]					P + T
	Ages and Stages Questionnaire[24]				P	
	Social Behavior Questionnaire[25]					P + T
Psychopathology	Child Behaviour Checklist (Preschool)[26,27]				P	P
	Caregiver-Teacher Report Form[28]					T
Impairment	Impairment Rating Scale[29]				P	P + T
Sleep/cry problems	Sleep and Settle Questionnaire[30]			I	I	I
Medical history	Medical history interview			I	I	I
Executive functioning	Childhood Executive Functioning Inventory[31]					P + T
Motor activity	10-min baby movements[32]			O		
	1 day with accelerometers				O	
Self-control	Present task[33]				O	
	Raisin task[34]					O
Social-communicative behaviour	Early social communication scales[35]			O		
Relationships with others and adjustment	Berkeley Puppet Interview[36,37]					C
About the parents						
Mood	In the last week, how happy were you?	P	P			
	In the last week, how anxious were you?	P	P			
	In the last week, how calm were you?	P	P			
	In the last week, how sad were you?	P	P			
Life events	How many good experiences did you have?	P	P			
	How many bad experiences did you have?	P	P			
	Life events questionnaire			P	P	P
	Life experience survey[38]			I	I	I
Pregnancy history	Pregnancy history, including substance use			I		
Family resources	Socioeconomic status			P	P	P
	Confusion, Hubbub, and Order Scale[39]			P	P	P
	Home Observation for Measurement of Environment Inventory[40]			O	O	O
Social support	Multidimensional scale of perceived social support[41]			P	P	P
Personality	Revised NEO Personality Inventory[42]			P	P	P
Psychopathology	Adult Self Report[28]			P	P	P
	Depression Impairment Scale for Parents[43]			P	P	P
Parents' relationship	Negative marital interactions[44]			P	P	P

(Continued)

Table 2 Continued

Construct	Instrument	Weekly during pregnancy	Weekly during first 12 weeks postnatal	T2 (3 months)	T3 (2.5 years)	T4 (4.5 years)
About parenting						
Parent-child interactions	Playing with toys 10 min with each parent[45]			O		
	Playing with toys, building tower and cleaning up 18 min with each parent				O	
	Etch-a-sketch[46] with each parent					O
	Disruptive Behavior Diagnostic Observation Schedule[47,48]					O
Parental stress	Parenting Stress Index[49,50]			P	P	P
Self-efficacy	Self-Efficacy for Parenting Tasks Index (Emotional availability, Play)[51]			P	P	P
Parent-child relationship quality	ALSPAC Positivity, Negativity[52]			P	P	P
	Postpartum Bonding Scale[53]			P		
	Parental behaviour checklist[54]				P	P
	Parental Cognitions and Conduct Toward the Infant Scale[55]			P		
	Parental protection scale[56]				P	P
Taking care of baby/child	Parental Involvement Scale #1 (Chores)[57]			P	P	P
	Parental Involvement Scale #2 (Days)[57]			I	I	I

TRAILS NEXT = the TRacking Adolescents' Individual Lives Survey: the next generation. P = Parent Questionnaire, I = Interview conducted by trained research assistant, O = Observation, C = Interview with the child, T = Teacher Questionnaire, NEO = Neuroticism-Extraversion-Openness, ALSPAC = Avon Longitudinal Study of Parents and Children.

child's peer relationships. Buccal cells for genotyping are collected from children at T3. In Spring 2021, we received permission from the Dutch National Institute for Public Health and the Environment (Ministry of Health, Welfare and Sport) to use dried blood spots from newborn blood screenings, which allows us to assess genetic information for all children born since 2015 and who will be born in the future, pending parental consent.

Parent-child relationship

At T2, T3 and T4 we zoom in on the parent-child relationship quality using repeated video observations of parent-child interactions that are micro- and macro-coded. We ask both 'social' parents, i.e. with whom the child lives, to take part in these tasks (separately).

Home environment and social support network

At T2, T3 and T4, we collect data on: household chaos, i.e. the level of disorganization, instability and environmental confusion; home environment from the observer perspective, i.e. living and play environment, hygiene in the household, interactions between family members; and family social resources, specifically each parent's perceived social support.

What has been found? Ongoing research in TRAILS NEXT

A range of projects are carried out in TRAILS NEXT which benefit from multigenerational data, including on intergenerational transmission of peer experiences and early social development. Here, the starting point is that social experiences in adolescence—specifically those with peers—do not just affect psychological development but might influence next-generation social development. For instance, a parent who has been bullied frequently in adolescence might be more likely to raise offspring to stand up against bullying or might, in contrast, be overprotective and controlling of offspring peer experiences. In TRAILS NEXT we study intergenerational processes and parenting mechanisms, as well as genetic confounding and genetic nurture as drivers of intergenerational continuity. TRAILS NEXT allows studying continuities between adolescent psychopathology, exposures during pregnancy and next-generation onset of psychopathology. For example, it is often assumed that exposures such

as stress and smoking during pregnancy are a direct cause in the development of neurodevelopmental problems such as ADHD. The prospectively collected multigenerational data in TRAILS NEXT allow us to test if exposures during pregnancy as such are causal or if the broader continuity between preconception psychopathology, including its risks (e.g. genetic risk, childhood adversity) and consequences (e.g. prenatal exposures, parenting), explains associations. Finally, TRAILS NEXT allows for sophisticated research into parents' developmental histories as determinants of parenting and parents' adjustment and health.[3] To this end, we conduct research into how individual variation in prenatal and postpartum sadness is explained by preconception mental health, and we study genetic and environmental interplay in early social and behavioural development.

What are the main strengths and weaknesses?

In addition to advantages inherent in the prospective, intergenerational design, TRAILS NEXT offers distinct strengths. First, fathers are included by design and should ultimately constitute half of the sample on which detailed developmental data are available. Second, we systematically and regularly enquire about pregnancies and are successful in including the majority of TRAILS participants who indicate being pregnant or fathering a pregnancy into the TRAILS NEXT sample. Third, we combine multiple assessment methods (one-on-one interviews, questionnaires, observations, experimental tasks, DNA) and collect information from mothers, fathers, children and teachers. Fourth, most constructs are assessed using multiple instruments and from multiple reporters to capture the many facets that constitute, for example, positive parent-child relationships or peer difficulties. The latter two strengths clearly distinguish TRAILS NEXT from larger birth cohorts, which seldom have resources to conduct such 'deep phenotyping'.

Longitudinal intergenerational data collection is challenging, as children are born over a long period of time. Results published on a part of the sample will carry some bias (e.g. young parents), and assessment methods and instruments that now constitute the state of the art may be replaced by technological and substantive advances in a few years. Also, we have rich and detailed information about the developmental past of one parent (the TRAILS index participant) but lack comparable prospective information on the child's other parent or other caregivers. Finally, given its relatively small base sample, TRAILS NEXT is challenged to ensure maximum inclusion to ensure power for complex analyses that tackle novel mechanisms.

Can I get hold of the data? Where can I find out more?

TRAILS NEXT is open to multicohort collaborations. With some delay, TRAILS NEXT data are also made available to researchers outside the TRAILS consortium, with availability communicated through DANS EASY [https/easy.dans.knaw.nl]. Apart from an administrative fee, data can be obtained without costs by submitting a publication proposal. Provided that the proposed publication does not overlap with other TRAILS publications and ongoing research, permission to use the requested data is given. More information and a publication proposal form can be obtained via the website [https://www.trails.nl/en] and the corresponding author.

Ethics approval

TRAILS NEXT was approved by the Dutch Central Committee on Research Involving Human Subjects (approval number NL47782.042.14).

Author contributions

C.A.H. is in charge of setting up the cohort study. C.A.H. and T.K. drafted the manuscript. T.K. and J.S.R. performed the data analysis of the manuscript. J.S.R., C.V., A.J.O. and A.M.O. contributed to the planning and the finalization of the manuscript.

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Conflict of interest

None declared.

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