Identification of child mental health problems in primary care: an interdisciplinary approach

Koning, N.R.

Chapter 6

Characteristics of youth in mental healthcare - can we identify different groups with routine healthcare data?

Nynke R. Koning, Frederike L. Büchner, Nathalie A. Leeuwenburgh, Irma J.M. Paijmans, D.J. Annemarie van Dijk-van Dijk, Robert R.J.M. Vermeiren, Matijs E. Numans, Mathilde R. Crone

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Abstract

Objectives: To gain insight into the characteristics of children using child and adolescent mental healthcare (CAMH) derived from primary care electronic health records.

Methods: Population-based retrospective cohort with children aged 0-19 years registered with 76 general practice (GP) centres in the Leiden area, the Netherlands. Anonymous data from GP centres, preventive youth healthcare (PYH) centres, and information regarding CAMH use from Statistics Netherlands was extracted and linked on an individual level. We investigated which children in CAMH were also identified with mental health problems (MHPs) in primary care, the timeline between recognition in primary care and CAMH use, and which characteristics were associated with CAMH use.

Results: Depending on age, 3 to 10% of the children either had first GP registered MHPs and/or were recorded in CAMH. Children only registered in CAMH without GP registered MHPs were less likely to have registered somatic complaints, chronic diseases, medication, laboratory tests, or high scores on MHP screening tools. PYH concerns for MHPs was a risk factor for CAMH use and/or GP recorded MHPs. Children with both MHPs and CAMH use were more often bullying/being bullied, underweight (age 12-18 years), or registered with school problems (age 4-11 years).

Conclusions: A limited number of characteristics were related to different groups of CAMH use. Future studies should further investigate children with CAMH use in absence of GP registered MHPs and explore structural information exchange between PYH and GP, as PYH concerns for MHPs was a risk factor for CAMH use and/or GP recorded MHPs.

Introduction

With a worldwide prevalence of 13.7%, mental health problems (MHPs) in children and adolescents are common(1). MHPs do not only impact the daily life and wellbeing of children and their families(2-4), but are also related to long-term effects such as adverse health, academic, work and social outcomes(4-7). The majority of MHPs start in childhood and adolescence(5, 8). As child MHPs can be treated effectively, early identification of child MHPs is important to provide adequate treatment and enable prevention of adverse outcomes later in life(9, 10). However, not all young people with MHPs receive help from mental health services(11, 12). National surveys in the UK, Australia and USA have estimated that only between one third and two thirds of young people with MHPs access mental health services(11-15).

Several stages and processes involved in the access to treatment for child MHPs have been described(15-17). The stages refer to 1) child and parental recognition of the problematic nature of the child's behaviour and the subsequent decision to consult a general practitioner (GP), 2) recognition of the child's problems by the GP, and 3) the GP's decision to refer to child and adolescent mental healthcare (CAMH). Characteristics of the child and the parents, such as symptom severity, MHP knowledge and perceived views towards MHPs and treatment, are found to influence these stages and thus access to treatment(15, 18-21). In addition, GPs perceived barriers to the recognition and effective management of child MHPs such as a lack of time, knowledge and resources including a shortage of providers and waiting lists(22).

Primary care practitioners are usually the first contacted professionals in case of health-related problems. In the UK and the Netherlands, GPs see children on average once a year and they are the main gatekeepers to specialized care, including CAMH(23, 24). In fact, approximately 80% of children and adolescents with MHPs consulted their GP within the preceding year(25). However, these children were often visiting for physical rather than psychological reasons and were often not recognized by their GP as having MHPs(25).

Not every child with MHPs needs CAMH. However, insight into the characteristics of children who use CAMH might support GPs in the identification of children in need of mental healthcare and might aid adequate treatment provision and prevent adverse outcomes later in life. The aim of this study was to gain more insight in which children used CAMH with information from electronic health records from primary care providers, including GPs and preventive youth healthcare professionals (see box 1) and information

regarding CAMH use. We investigated which children in CAMH were also identified with MHPs in primary care, what the timeline was between recognition in primary care and CAMH use, and which characteristics of the child, family and healthcare were associated with CAMH use.

Box 1- Primary care for children in the Netherlands

In the Netherlands, next to GPs, physicians and nurses working in preventive youth healthcare (preventive youth healthcare professionals, (PYHPs)) are the key players in providing primary care for children(26). GPs provide acute and chronic care for children and their families. PYHPs see all children under 19 year regularly during standardized visits to monitor a child's healthy development(27).

Methods

Study design, setting and population

Data from three different sources were used: routine electronic health record data extracted from general practice centres and from preventive youth healthcare centres, and health costs related to child and adolescent mental healthcare (CAMH). This study is part of a larger research project, the nature and quality of the data extracted from GPs(28) and PYHPs centres (Koning et al, Identification of child mental health problems by combining electronic health record information from different primary healthcare professionals – a population-based cohort study. Under revision, BMJ Open) are described elsewhere in more detail.

A population-based retrospective cohort including children registered with 76 general practice centres that were affiliated with the ELAN primary care network (Extramural LUMC Academic Network) of the Leiden University Medical Centre (LUMC), the Netherlands was used. All patients aged 0-19 years on 31 December 2016 and registered with participating general practice centres between 1 January 2007 and 1 January 2017 for at least one year were part of the original cohort(28). The GP data consisted of demographics, consultation dates, symptoms and diagnoses coded according to the WHO International Classification of Primary Care (ICPC), prescribed medication coded according to the Anatomical Therapeutic Chemical (ATC) classification, laboratory test results, and descriptive or coded information from referrals and correspondence with other healthcare professionals(28-30). For the included children we obtained anonymously extracted data from preventive youth healthcare (PYH) centres that were part of the Regional Public Health Service Hollands Midden. The PYH data included demographics, information regarding pregnancy, family and social circumstances and information from scheduled visits and extra consultations with PYH(31). Because of policy changes, information regarding costs made in CAMH was only available for the period between 2009 and 2014. And so for this present study, we included children with data from general practice and PYH from the period between 2008 and 2014, and with data regarding CAMH use from the period between 2009 and 2014 (Figure 1).The coded data from general practice and PYH were anonymously linked by a third trusted party(32). The linked general practice and PYH data were then anonymously linked to data from Statistics Netherlands, so that access to non-public microdata regarding healthcare insurances and subsequently (mental) healthcare costs could be organized. Information regarding CAMH use was based on mental healthcare cost data.

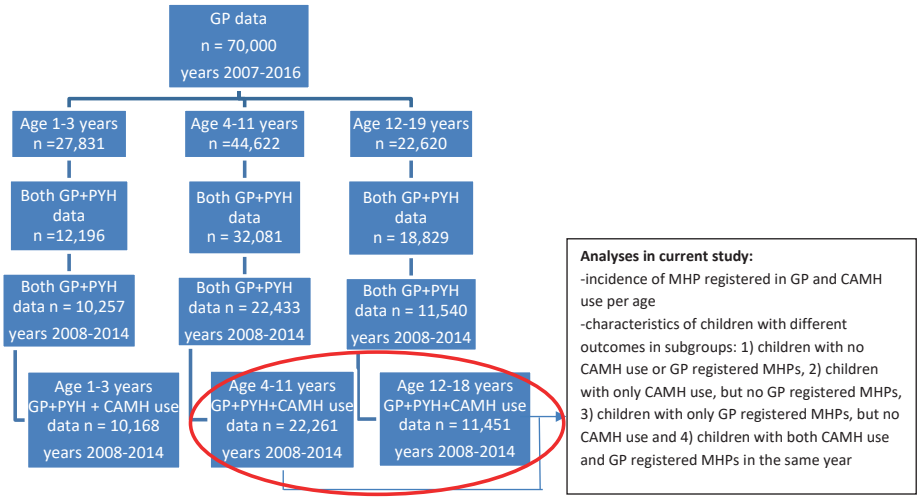

Figure 1. Flowchart of original cohort and the children included in the current study

Analyses in current study:
-incidence of MHP registered in GP and CAMH use per age
-characteristics of children with different outcomes in subgroups: 1) children with no CAMH use or GP registered MHPs, 2) children with only CAMH use, but no GP registered MHPs, 3) children with only GP registered MHPs, but no CAMH use and 4) children with both CAMH use and GP registered MHPs in the same year
CAMH = child and adolescent mental healthcare, GP = general practice, MHPs = mental health problems, PYH = preventive youth healthcare

Outcomes

We categorized first recorded child and adolescent mental healthcare use (CAMH use) and/or GP registered MHPs in the same year into different subgroups: 1) children with neither in that year, 2) children with only CAMH use, but no GP registered MHPs, 3) children with only GP registered MHPs, but no CAMH use and 4) children with both CAMH use and GP registered MHPs in the same year.

The first recorded use of child and adolescent mental healthcare (CAMH use) was based on the presence of any healthcare costs made for mental health other than in general practice per calendar year in the microdata from Statistics Netherlands. A first recorded child MHP based on general practice data was defined when at least one of the following was present: a recorded MHP, a referral to child mental healthcare and/or a mental health medication prescription between 1 January 2009 and 1 January 2015 (Supplement Table 1). We defined a recorded MHP when ICPC codes from the P (psychological) chapter and/or ICPC code T06 ('anorexia nervosa/bulimia') were

present, including both mental health symptoms as well as hypothesized and confirmed disorders. Related mental health medication prescriptions were defined as prescriptions coded with ATC codes N05A, N05B, N05C, N06A, N06BA02, N06BA04, N06BA09, N07BA, or N07BB. Referrals to child mental healthcare were defined as referrals to a psychologist, psychiatry, or psychotherapy(28).

Characteristics of youth in child and adolescent mental healthcare

Characteristics of CAMH use were related to the child (e.g. gender, developmental characteristics), medical history (e.g. somatic complaints, co-morbidities, number of GP visits), possible MHPs (e.g. results of validated mental health screening tools such as the Strengths and Difficulties Questionnaire (SDQ)), and the family/context (e.g. parental education, socioeconomic status and family MHPs) (Supplement Table 2 and 3). Characteristics were selected based on literature regarding risk factors for MHPs and an expert panel(33, 34). Regarding the general practice data, every first occurrence of a characteristic was taken into account as GPs see patients on an irregular, patient-determined basis. We assumed that in case a characteristic was not registered, it was absent(35).

PYHPs see children regularly during routine visits in which standard items should be checked and recorded. During the first four years of life, about 15 PYH visits are scheduled. In both primary school (children age 4-11 years) and secondary school, (children age 12-18 years) children are generally seen twice(27). Regarding PYH characteristics we assumed that in case of missingness the characteristics were normal(35). Some PYH characteristics can change over time, we then included either the first (e.g. for bullying or school problems) or last (e.g. for overweight) registered value at T0. For the other characteristics we included the first known registered value (Supplement Table 3). Due to sparseness of the data, we clustered closely related characteristics(31).

As characteristics may vary across childhood and adolescence, we investigated the characteristics for the age groups primary school aged children (aged 4-11 years) and secondary school aged children (aged 12-19 years) separately. The same set of characteristics was examined in the different age groups; however we required the prevalence of a characteristic to be >1% per subgroup with regard to the clinical usefulness of the characteristic.

Statistical analyses

Descriptive statistics were carried out with IBM SPSS (version 25, Armonk, NY). We investigated the incidence of CAMH use per age, and the overlap in children in CAMH and children with recorded MHPs by GPs for the period between 2009 and 2014. A

timeline of recorded MHPs by GPs versus CAMH use was made. We calculated the prevalence of characteristics for all children and the subgroups children with only CAMH use, only MHPs, and both MHPs and CAMH use in each specific year.

To examine which characteristics were related to the different subgroups, we used multilevel logistic regression analysis per age group, primary school aged children and secondary school aged children. First, the data were split according to the children's age; age 4 years, age 5 years and so on. For every age, (timepoint 0 (T0)) the status of all characteristics was updated at the same time at that specific age and the outcomes CAMH use and/or MHPs based on GP data were assessed 1 year later (timepoint 1 (T1), Figure 2)(28). As CAMH use (T1) was available between 2009 and 2014, the status of characteristics (T0) was assessed between 2008 and 2013. By combining the data from those years (e.g. age 4-11 years) and fitting a logistic regression model including a cluster effect on the patient level with R (version 3.5.3, Vienna, Austria), we obtained the characteristics of the different subgroups per age group. This to adjust for using different age years of one patient, for instance at age 4 years and age 5 years(36). Children with CAMH use and/or MHPs before T0 were excluded from the analyses. The Ethics Committee of the Leiden University Medical Centre issued a waiver of consent (G16.018).

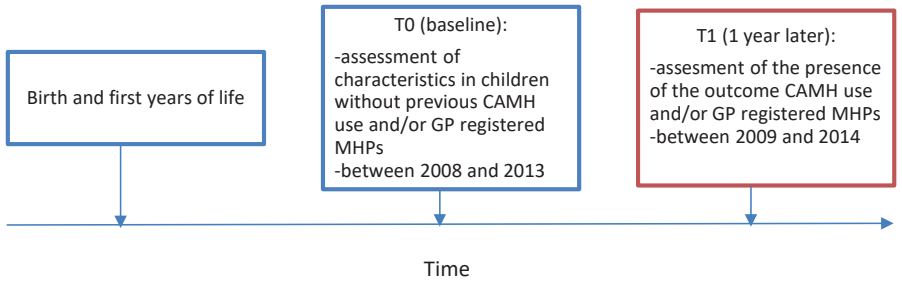

Figure 2. Timeline of analyses in children under 19 years old

CAMH = child and adolescent mental healthcare, GP = general practitioner, MHPs = mental health problems

Results

Our original cohort of general practice data from the period between 2007 and 2017 included 70,000 children(28). From 48,256 children (68.9% of those included in the original cohort), data extracted from PYH could be individually linked to the general practice data and for 63,675 children (91% of those included), data from Statistics Netherlands were available. For the period between 2008 and 2014, we could link information from general practice and PYH to information regarding CAMH use for 22,261 children aged 4-11 years and for 11,451 children aged 12-18 years (Figure 1) and those children were included in the present study. Characteristics of the children in these two age cohorts can be found in Table 1 and Table 2.

Prevalence of MHP and CAMH use

For 48,915 children who were enlisted with participating general practice centres between 2008 and 2014, information regarding CAMH use was available. Over the whole period, the prevalence of children registered with both MHPs according to GPs and CAMH use was about ten percent (n=5,283) Six percent were registered as using CAMH but had no GP recorded MHPs and vice versa 12% of the children were registered with MHPs recorded by GPs but were not registered in CAMH. In about half of the 5,283 children with both MHPs and CAMH use, these occurred in the same calendar year (Figure 3). In 18% of the children with both MHPs and CAMH use, CAMH use was recorded before MHPs were recorded by GPs.

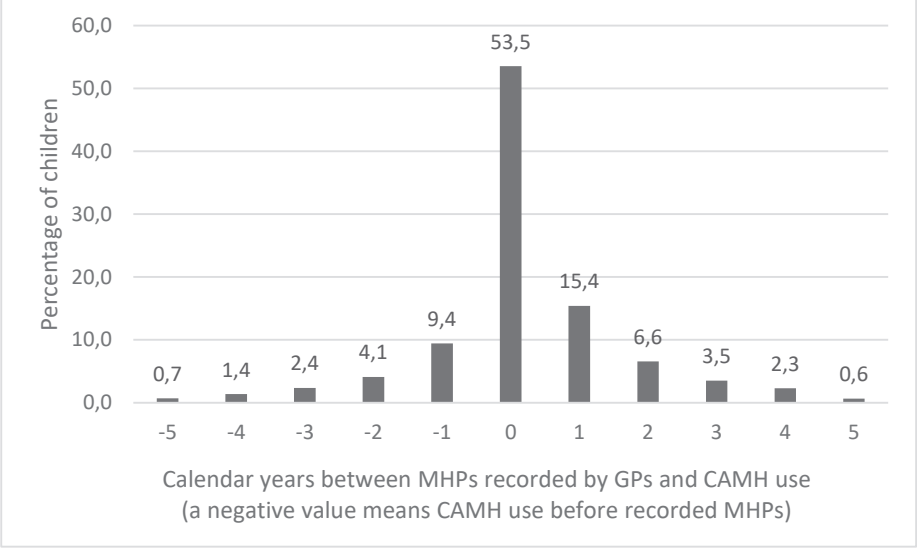

Figure 3. Timeline between GP recorded MHPs and CAMH use between 2009 and 2014 in children under 19 years old

Table 1. Baseline characteristics of children age 4-11 years, including subgroups with different outcomes compared to children without any outcome[a]

Characteristics	**All children n=22,261, %(n)**
Child	
Male gender	48.1 (10,713
Ethnicity[b]	3.1 (698)
Developmental problems	
Developmental problems[b]	3.0 (658)
Difficult temperament	2.7 (611)
Incontinence[b]	3.4 (750)
Sleeping problems[b]	0.6 (244)
Eating problem[b]	0.9 (198)
Overweight[b]	8.2 (1,822)
Underweight[b]	11.0 (2,444)
School problem	2.6 (569)
Secondary school level low[b]	X (X)
Bullying/being bullied[b]	0.8 (188)
Low self-confidence/resilience[b]	0.6 (142)
High technology use[b]	2.0 (455)
Life events	0.7 (148)
Life events[b]	10.6 (2,354)
Medical history	
Non-spontaneous birth[b]	8.0 (1,777)
Premature[b]	2.7 (603)
Perinatal morbidity	2.9 (433)
Neonatal problems[b]	1.5 (328)
Congenital anomaly	12.7 (2,827)
Chronic disease[c]	42.2 (9,403)
Somatic complaints[d]	35.0 (7,789)
Tension headache[e]	3.4 (759)
Migraine[e]	0.4 (81)
Abdominal pain[e]	12.8 (2,841)
Constipation[e]	14.4 (3,201)
Tiredness[e]	4.8 (1,065)
Other somatic complaints[e]	11.6 (2,593)

	Children with only CAMH use n=1,284 [a], %(n)	Children with only MHP use n=2,065[a], %(n)	Children with MHP and CAMH use n=882[a], %(n)
	56.2 (722)	57.8 (1,194)	60.1 (530)
	0.9 (11)	2.6 (53)	1.9 (17)
	4.2 (54)	4.7 (97)	6.1 (54)
	1.0 (13)	3.6 (75)	1.5 (13)
	5.1 (65)	7.1 (147)	4.2 (37)
	1.4 (18)	1.4 (29)	X (X)
	1.5 (19	1.5 (30)	1.4 (12)
	4.3 (55)	7.3 (150)	6.2 (55)
	7.6 (97)	9.5 (197)	7.9 (70)
	4.8 (61)	3.5 (73)	6.5 (57)
	1.2 (16)	X (X)	1.8 (16)
	1.2 (16)	1.3 (26)	2.9 (26)
	1.2 (15)	1.0 (20)	1.2 (11)
	X (X)	X (X)	X (X)
	0.9 (12)	1.3 (27)	X (X)
	163 (12.7)	11.6 (239)	12.0 (106)
	1.5 (19)	4.8 (99)	3.3 (29)
	0.8 (10)	2.4 (50)	1.2 (11)
	1.0 (13)	2.6 (53)	1.7 (15)
	2.3 (29)	1.8 (37)	2.0 (18)
	13.6 (175)	14.2 (293)	15.0 (132)
	35.9 (461)	44.9 (927)	45.1 (398)
	32.6 (418)	37.5 (775)	37.4 (330)
	3.7 (48)	3.9 (81)	4.9 (43)
	X (X)	X (X)	X (X)
	11.3 (145)	13.7 (283)	13.5 (119)
	12.9 (165)	17.4 (359)	14.6 (129)
	6.0 (77)	5.2 (107)	6.6 (58)
	9.6 (123)	11.6 (240)	12.4 (109)

Table 1. Continued

Characteristics	**All children n=22,261, %(n)**
Neoplasms	4.8 (1,066)
>2 GP Visits in previous year	85.3 (18,982)
≥1 Medication prescript in previous year	67.5 (15,025)
≥1 Laboratory test in previous year	18.4 (4,107)
≥1 Referral/correspondence other healthcare professional in previous year	61.5 (13,694)
Under treatment other than PYH[b]	6.8 (1,522)
Total referral by PYH[b]	7.9 (1,752)
Extra healthcare visit in PYH[b]	33.9 (7,544)
MHP related	
cMHP[b]	18.9 (4,202)
SDQ borderline[b]	4.2 (929)
SDQ increased[b]	2.2 (489)
Parent/family/environment	
Family history of MHP[b]	3.5 (773)
Chronic illness parent[b]	3.2 (713)
Risk factor parents[b]	10.9 (2,435)
Prenatal risk factors[b]	3.2 (717)
Non-traditional family composition[b]	4.0 (889)
Low Socioeconomic status	3.1 (694)
Negative balance	1.3 (289)
Little confidence in parenting skills	1.3 (292)
Environmental stressors[b]	8.1 (1,796)

CAMH = child and adolescent mental healthcare, cMHP = concern for mental health problem according to preventive youth healthcare, GP = general practice, KIVPA = short indicative questionnaire for psychosocial problems among adolescents, MHP = mental health problem, PYH = preventive youth healthcare, SDQ = Strengths and difficulties questionnaire, X = when prevalence of characteristic <10, related percentages was then also blinded

[a] Subgroups are compared with children without any outcome, i.e. with no CAMH use and no MHP registered by GP.

[b] Characteristic based on information from PYH, other characteristics are based on information from GP.

[c] Chronic disease when present one or more of the following: asthma, eczema, psoriasis, inflammatory bowel disease, epilepsy, diabetes mellitus, cystic fibrosis, rheumatoid arthritis.

Children with only CAMH use n=1,284 [a], %(n)	Children with only MHP use n=2,065[a], %(n)	Children with MHP and CAMH use n=882[a], %(n)
5.7 (73)	5.5 (114)	6.5 (57)
85.8 (1,102)	89.2 (1,842)	89.7 (791)
68.1 (874)	71.5 (1,477)	75.3 (664)
19.7 (253)	19.4 (400)	21.8 (192)
66.0 (848)	66.3 (1,369)	69.0 (609)
13.7 (176)	10.4 (214)	12.8 (113)
4.8 (61)	9.0 (186)	7.4 (65)
34.6 (444)	37.0 (765)	36.4 (321)
29.6 (380)	24.8 (51.3)	35.6 (314)
6.2 (80)	4.9 (102)	10.5 (93)
3.9 (50)	3.4 (71)	6.1 (54)
3.8 (49)	3.8 (79)	5.1 (45)
1.3 (17)	2.8 (57)	2.2(19)
11.3 (145)	11.5 (238)	12.9 (114)
1.1 (14)	1.7 (35)	1.5 (13)
2.5 (32)	3.5 (72)	2.9 (26)
1.8 (23)	3.0 (62)	2.4 (21)
0.9 (11)	1.9 (40)	1.2 (11)
2.8 (36)	1.8 (38)	3.5 (31)
3.2 (41)	6.0 (123)	5.4 (48)

[d] Somatic complaint when present one or more of the following: tension headache, migraine, abdominal pain, constipation, tiredness, irritable bowel syndrome IBS, musculoskeletal symptoms, dizziness, nausea, hyperventilation syndrome, palpitations, fainting.
[e] Separate somatic complaints do not add up to the total amount of somatic complaints as a child can have multiple somatic complaints.
Characteristics prevalent in <1% of all children and therefore not included in table:
-GP based characteristics: academic problems, disabilities
-PYH based characteristics: excessive crying, negative weight perception, school level high and other, bad relationship with ≥1 parent, unemployment/financial distress of the child, self-harm, female genital mutilation, insufficient physical exercise, substance use, energy drink consumption, KIVPA increased, poorly experienced health, parental concerns about child.
Characteristic 'member of hobby/music club' was registered in >90% of all (subgroup) children

Table 2. Baseline characteristics of children age 12-18 years, including subgroups with different outcomes compared to children without any outcome[a]

Characteristics	**All children n=11,451, %(n)**
Child	
Male gender	46.8 (5,355)
Ethnicity	1.2 (133)
Developmental problems	2.5 (282)
Developmental problems[b]	1.1 (131)
Incontinence	2.3 (265)
Sleeping problems[b]	1.2 (136)
Eating problem[b]	1.3 (147)
Overweight[b]	13.9 (1,586)
Underweight[b]	7.6 (874)
School problem	5.4 (615)
Secondary school level low[b]	12.3 (1,407)
Secondary school level high[b]	7.1 (814)
Bullying/being bullied[b]	4.5 (511)
Substance use[b]	3.2 (352)
High technology use[b]	3.2 (352)
Life events	1.2 (133)
Life events[b]	11.7 (1,345)
Medical history	
Non-spontaneous birth[b]	1.5 (171)
Congenital anomaly	17.2 (1,965)
Disabilities	X (X)
Chronic disease[c]	33.7 (3,856)
Somatic complaints[d]	41.9 (4,794)
Tension headache[e]	7.0 (804)
Migraine[e]	1.8 (202)
Abdominal pain[e]	13.5 (1,546)
Constipation[e]	8.5 (979)
Tiredness[e]	9.7 (1,116)
Other somatic complaints[e]	21.8 (2,498)
Neoplasms	5.2 (596)
>2 GP Visits in previous year	83.5 (9,558)

	Children with only CAMH use n=528[a], %(n)	Children with only MHP use n=811[a], %(n)	Children with MHP and CAMH use n=482[a], %(n)
	39.0 (206)	41.6 (337)	36.7 (177)
	X (X)	X (X)	X (X)
	2.3 (12)	1.6 (13)	X (X)
	X (X)	X (X)	X (X)
	X (X)	2.8 (23)	X (X)
	1.9 (10)	X (X)	2.3 (11)
	X (X)	2.6 (21)	X (X)
	8.3 (44)	12.0 (97)	11.2 (54)
	4.2 (22)	5.8 (47)	3.5 (17)
	6.1 (32)	5.5 (45)	7.3 (35)
	4.5 (24)	10.6 (86)	9.1 (44)
	3.4 (18)	5.3 (43)	5.0 (24)
	3.0 (16)	4.2 (34)	4.8 (23)
	2.3 (12)	4.4 (36)	2.9 (14)
	X (X)	1.4 (11)	X (X)
	X (X)	2.5 (20)	X (X)
	12.3 (65)	13.6 (110)	13.5 (65)
	X (X)	X (X)	X (X)
	21.6 (114)	20.3 (165)	22.0 (106)
	X (X)	X (X)	X (X)
	29.7 (157)	35.9 (291)	35.7 (172)
	35.2 (186)	47.0 (381)	47.1 (227)
	6.8 (36)	9.1 (74)	7.5 (36)
	X (X)	2.3 (19)	2.3 (11)
	10.0 (53)	15.3 (124)	16.2 (78)
	9.1 (48)	7.4 (60)	11.6 (56)
	8.7 (46)	11.2 (91)	11.0 (53)
	17.8 (94)	25.9 (210)	25.7 (124)
	3.8 (20)	4.3 (35)	4.8 (23)
	82.6 (436)	86.4 (701)	85.9 (414)

Table 2. Continued

Characteristics	**All children n=11,451, %(n)**
≥1 Medication prescript in previous year	67.1 (7,681)
≥1 Laboratory test in previous year	27.4 (3,140)
≥1 Referral/correspondence other healthcare professional in previous year	60.2 (6,899)
Under treatment other than PYH[b]	6.7 (770)
Total referral in past year by PYH[b]	1.9 (216)
Extra healthcare visit in PYH[b]	22.1 (2,532)
MHP related	
cMHP[b]	38.3 (4,385)
SDQ borderline[b]	3.7 (421)
SDQ increased[b]	2.2 (253)
KIVPA increased[b]	7.2 (819)
Parent/family/environment	
Family history of MHP[b]	1.2 (143)
Chronic illness parent[b]	0.8 (96)
Risk factor parents[b]	11.2 (1,283)
Non-traditional family composition[b]	5.9 (678)
Low Socioeconomic status	3.5 (397)
Environmental stressors[b]	3.4 (391)

CAMH = child and adolescent mental healthcare. cMHP = concern for mental health problem according to preventive youth healthcare, GP = general practice, KIVPA = short indicative questionnaire for psychosocial problems among adolescents

MHP = mental health problem, PYH = preventive youth healthcare, SDQ = Strengths and difficulties questionnaire

X = when prevalence of characteristic <10, related percentages was then also blinded. However, this percentage could still be ≥1%, so that characteristic could still be included in logistic regression analyses

[a] Subgroups are compared with children without any outcome, i.e. with no CAMH use and no MHP registered by GP.

[b] Characteristic based on information from PYH, other characteristics are based on information from GP.

[c] Chronic disease when present one or more of the following: asthma, eczema, psoriasis, inflammatory bowel disease, epilepsy, diabetes mellitus, cystic fibrosis, rheumatoid arthritis.

Children with only CAMH use n=528[a], %(n)	Children with only MHP use n=811[a], %(n)	Children with MHP and CAMH use n=482[a], %(n)
63.3 (334)	71.5 (580)	74.1 (357)
24.2 (128)	32.8 (266)	30.5 (147)
58.1 (307)	65.1 (528)	69.9 (337)
6.3 (33)	7.8 (63)	7.1 (34)
X (X)	1.2 (10)	X (X)
27.3 (144)	28.9 (234)	26.8 (129)
38.6 (204)	41.6 (337)	43.8 (211)
5.1 (27)	4.4 (36)	5.4 (26)
3.8 (20)	2.7 (22)	4.1 (20)
8.5 (45)	11.8 (96)	12.4 (60)
2.8 (15)	1.8 (15)	2.3 (11)
X (X)	x (X)	X (X)
10.2 (54)	15.7 (127)	12.2 (59)
3.0 (16)	6.4 (52)	4.8 (23)
2.7 (14)	2.2 (18)	3.1 (15)
2.7 (14)	X (X)	X (X)

[d] Somatic complaint when present one or more of the following: tension headache, migraine, abdominal pain, constipation, tiredness, irritable bowel syndrome IBS, musculoskeletal symptoms, dizziness, nausea, hyperventilation syndrome, palpitations, fainting.
[e] Separate somatic complaints do not add up to the total amount of somatic complaints as a child can have multiple somatic complaints.
Characteristics prevalent in <1% of all children and therefore not included in table:
-GP based characteristics: academic problems, disabilities, perinatal problems
-PYH based characteristics: difficult temperament, parental concerns about child, negative balance, poorly experienced health, energy drink consumption, self-harm, female genital mutilation, secondary school level other, negative weight perception, little confidence parenting skills, insufficient physical exercise, excessive crying, premature, neonatal problems, unemployment/financial distress of the child, low self-confidence/resilience, bad relationship with ≥1 parent, prenatal risk factors
Characteristic 'member of hobby/music club' was registered in >90% of all (subgroup) children

The incidence of children with either a first GP registered MHPs or first recorded CAMH use in the same year ranged between 5.6% and 9.6% for children aged 4-11 years and between 4.9% and 6.8% for children aged 12-18 years (Table 3). The majority of the youngest (4 to 7 years) and oldest (17 and 18 years) children had a GP registered MHP and were less often found in the CAMH use registration. Children aged 7 to 14 were most often found in either the CAMH or in the GP registration but less often in both registrations.

Characteristics of children with MHPs and/or CAMH use

The characteristics of children in the subgroups children with only CAMH use, only GP registered MHPs, and both CAMH use and GP registered MHPs are depicted in Table 4 (children aged 4-11 years) and Table 5 (children aged 12-18 years).

Characteristics of the child

In children aged 4-11 years, boys more often used CAMH and/or were registered with MHPs by the GP compared to the group of children without any MHPs or CAMH use. School problems were associated with CAMH use with and without GP registered MHPs. Bullying/being bullied was associated with having both recorded CAMH use and GP registered MHPs. Difficult temperament and incontinence were related to GP registered MHPs without recorded CAMH use.

In contrast to the primary school-aged children, adolescents in the age group 12-18 years were more often female when having GP registered MHPs with and without CAMH use. In addition, exposure to life events was associated with GP registered MHPs with and without CAMH use. Being underweight or being a member of a hobby or music group made it more likely to be registered with both MHPs and CAMH use.

Characteristics of the child's medical history

Regarding children aged 4-11 years old, children with only CAMH use and no GP registered MHPs had less chronic diseases, were less overweight, and they were more often under treatment elsewhere (not in PYH) compared to the other subgroups. The adolescents aged 12-18 years who used CAMH but who were not registered with MHPs by the GP did not differ significantly from the group without both CAMH use and GP registered MHPs regarding most characteristics related to the medical history. They only more often had an extra health care visit in PYH. In contrast, the adolescents with a GP registered MHP with or without CAMH use were more often known with chronic diseases, somatic complaints, and medication prescriptions or laboratory tests in the previous year. The adolescents with only CAMH use were less often registered with a lower secondary school level and were also less overweight.

Table 3. First recorded GP recorded MHPs and CAMH use per age between 2009 and 2014

Child age (years)	Nr of children without previous MHP or CAMH use at T0, n	Children with only MHP at T1, % (n)	Children with only CAMH use at T1, % (n)	Children with both MHP and CAMH use at T1, % (n)	Total Children with MPH and/ or CAMH % (n)
1	3,580	3.0 (109)	X (X)	X (X)	3.0 (109)
2	13,327	3.8 (511)	0.4 (56)	0.3 (34)	4.5 (601)
3	13,254	3.9 (522)	0.5 (68)	0.5 (64)	4.9 (654)
4	13,079	4.3 (558)	1.0 (127)	0.6 (77)	5.9 (762)
5	12,895	4.9 (636)	1.4 (181)	1.0 (126)	6.3 (943)
6	12,543	4.1 (508)	2.0 (248)	1.7 (215)	7.8 (971)
7	12,211	4.2 (513)	3.1 (379)	2.3 (285)	9.6 (1,177)
8	11,837	3.2 (380)	3.8 (453)	2.2 (259)	9.2 (1,092)
9	11,614	3.4 (394)	3.5 (402)	1.8 (203)	8.7 (999)
10	11,330	2.9 (323)	3.4 (385)	1.5 (167)	7.8 (875)
11	11,044	2.2 (244)	2.0 (225)	1.4 (152)	5.6 (621)
12	11,022	1.8 (201)	1.9 (206)	1.2 (133)	4.9 (540)
13	10,946	1.8 (199)	1.8 (197)	1.4 (150)	5.2 (546)
14	8,928	2.4 (216)	2.1 (185)	1.5 (130)	6.0 (531)
15	6,913	2.5 (173)	1.7 (118)	1.6 (113)	5.8 (404)
16	4,970	2.7 (135)	1.7 (83)	1.6 (79)	6.0 (297)
17	3,206	4.2 (136)	1.3 (43)	1.3 (43)	6.8 (222)
18	1,506	4.6 (69)	X (X)	1.2 (18)	5.8 (87)

CAMH = child and adolescent mental healthcare, MHP = mental health problem, T0 = timepoint 0, timepoint of measurement of baseline characteristics, T1 = timepoint 1, timepoint of measuring outcomes, 1 year after T0, X = number of children <10, subsequent percentage was therefore also erased

Characteristics related to MHPs

PYH concerns for MHPs were associated with MHPs registered by the GP and/or CAMH use in primary and secondary school-aged children in nearly all subgroups. Only in children aged 4-11 years it was not associated with children having both MHPs and CAMH use. Regarding scores on mental health screening tools, only increased KIVPA scores were associated with an increased risk of GP registered MHPs with and without CAMH use in secondary school-aged children.

Table 4. Characteristics of children age 4-11 years with only CAMH use, only MHPs and both CAMH use and MHPs

Characteristics	**Children with only CAMH use n=1,284[a] Total person years 51,432 OR (95% CI)**
Child	
Male gender	1.44 (1.28-1.61)
Ethnicity[b]	NA
Developmental problems	
Developmental problems[b]	
Difficult temperament	0.57 (0.33-0.98)
Incontinence[b]	
Sleeping problems[b]	
Eating problem[b]	
Overweight[b]	0.69 (0.52-0.91)
Underweight[b]	
School problem	1.36 (1.02-1.80)
Secondary school level low[b]	
Bullying/being bullied[b]	
Low self-confidence/resilience[b]	
Member of hobby or music club	
Life events	NA
Life events[b]	1.28 (1.07-1.52)
Medical history	
Non-spontaneous birth[b]	0.48 (0.30-0.76)
Premature[b]	NA
Perinatal morbidity	
Neonatal problems[b]	
Congenital anomaly	
Chronic disease[c]	0.39 (0.34-0.44)
Somatic complaints[d]	
Neoplasms	
>2 GP Visits in previous year	
≥1 Medication prescript in previous year	
≥1 Laboratory test in previous year	
≥1 Referral/correspondence other healthcare professional in previous year	1.21 (1.07-1.37)

	Children with only MHP n=2,065[a] Total person years 52,213 OR (95% CI)	Children with MHP and CAMH use n=882[a] Total person years 51,030 OR (95% CI)
	1.54 (1.41-1.69)	1.61 (1.40-1.86)
	1.38 (1.10-1.73)	1.44 (1.06-1.95)
	1.45 (1.13-1.85)	
	1.72 (1.42-2.09)	0.61 (0.43-0.86)
		1.151 (1.12-2.05)
	NA	
		2.48 (1.52-4.04)
	2.27 (1.51-3.42)	NA
		1.23 (1.02-1.49)
	1.15 (1.05-1.27)	1.19 (1.03-1.37)
	1.25 (1.14-1.37)	1.26 (1.09-1.45)
	1.29 (1.13-1.47)	
		1.31 (1.11-1.54)
	1.25 (1.13-1.38)	1.21 (1.04-1.40)

Table 4. Continued

Characteristics	**Children with only CAMH use n=1,284[a] Total person years 51,432 OR (95% CI)**
Under treatment other than PYH[b]	1.20 (1.02-1.43)
Total referral by PYH[b]	
Extra healthcare visit in PYH[b]	
MHP related	
cMHP[b]	1.63 (1.41-1.88)
SDQ borderline[b]	
SDQ increased[b]	
Parent/family/environment	
Family history of MHP[b]	
Chronic illness parent[b]	
Risk factor parents[b]	
Prenatal risk factors[b]	
Non-traditional family composition[b]	
Low Socioeconomic status	
Negative balance	NA
Little confidence in parenting skills	
Environmental stressors[b]	

Only characteristics with significant associations with the outcome (i.e. OR doesn't contain 1) are presented, characteristics that were not included in the model with the specific outcome in this age group because of a prevalence <1% are presented with not applicable (NA)

	Children with only MHP n=2,065[a] Total person years 52,213 OR (95% CI)	Children with MHP and CAMH use n=882[a] Total person years 51,030 OR (95% CI)
	1,20 (1,07-1,35)	
	1.16 (1.02-1.31)	
		2.00 (1.51-2.65)
	1.54 (1.13-2.09)	

Table 5. Characteristics of children age 12-18 years with only CAMH use, only MHPs and both CAMH use and MHPs

Characteristics	**Children with only CAMH use n= 528 Total person years 32,293 OR (95% CI)**
Child	
Male gender	0.70 (0.59-0.84)
Ethnicity[b]	
Developmental problems	
Developmental problems[b]	
Incontinence	
Sleeping problems[b]	
Eating problem[b]	
Overweight[b]	0.70 (0.50-0.96)
Underweight[b]	
School problem	
Secondary school level low[b]	0.53 (0.34-0.82)
Secondary school level high[b]	
Bullying/being bullied[b]	
Substance use[b]	
Member of hobby or music club	
High technology use[b]	
Life events	NA
Life events[b]	
Medical history	
Congenital anomaly	
Disabilities	NA
Chronic disease[c]	
Somatic complaints[d]	
Neoplasms	
>2 GP Visits in previous year	
≥1 Medication prescript in previous year	
≥1 Laboratory test in previous year	
≥1 Referral/correspondence other healthcare professional in previous year	1.26 (1.04-1.54)
Under treatment other than PYH[b]	
Total referral by PYH[b]	
Extra healthcare visit in PYH[b]	1.55 (1.20-2.01)

	Children with only MHPs n= 811 Total person years 32,576 OR (95% CI)	Children with MHP and CAMH use n= 482 Total person years 32,247 OR (95% CI)
	0.83 (0.72-0.96)	0.67 (0.56-0.82)
		0.47 (0.35-0.63)
		1.75 (1.06-2.91)
		1.73 (1.42-2.11)
	2.32 (1.45-3.71)	NA
	1.36 (1.10-1.69)	1.36 (1.03-1.80)
	NA	
	1.24 (1.06-1.44)	
	1.45 (1.24-1.68)	1.43 (1.18-1.74)
		1.34 (1.08-1.66)
	1.37 (1.14-1.65)	
	1.25 (1.07-1.46)	1.51 (1.23-1.85)

Table 5. Continued

Characteristics	Children with only CAMH use n= 528 Total person years 32,293 OR (95% CI)
MHP related	
cMHP[b]	1.45 (1.18-1.79)
SDQ borderline[b]	
SDQ increased[b]	
KIVPA increased[b]	
Parent/family/environment	
Family history of MHP[b]	2.39 (1.38-4.14)
Risk factor parents[b]	0.73 (0.55-0.97)
Non-traditional family composition[b]	
Low Socioeconomic status	
Little confidence in parenting skills	
Environmental stressors[b]	

Only characteristics with significant associations with the outcome (i.e. OR doesn't contain 1) are presented, characteristics that were not included in the model with the specific outcome in this age group because of a prevalence <1% are presented with not applicable (NA)

Characteristics related to the parent, family or environment

Characteristics related to the parent, family or environment were not associated with MHPs and/or CAMH use in children aged 4-11 years. In adolescents aged 12-18 years, a family history of MHPs was positively associated with only CAMH use, while other adverse parental risk factors, such as unemployment or being abused in childhood, decreased the likelihood of CAMH use. These adverse parental risk factors and a family composition other than 2 biological parents increased the risk of GP registered MHPs without CAMH use.

	Children with only MHPs n= 811 Total person years 32,576 OR (95% CI)	Children with MHP and CAMH use n= 482 Total person years 32,247 OR (95% CI)
	1.26 (1.06-1.49)	1.47 (1.18-1.83)
	1.58 (1.25-2.00)	1.64 (1.22-2.21)
	1.24 (1.02-1.52)	
	1.52 (1.11-2.08)	

Discussion

In this population-based retrospective cohort study, we obtained further insight into the children who use child and adolescent mental healthcare (CAMH). Our study found that depending on age, 3 to 10% of the children had either a first GP-registered MHP and/or were recorded in CAMH. About 20 to 25% of these children were known both in the GP-registration and in the CAMH-registration. The 4–11-year-olds had a relatively large proportion of children with only GP registered MHPs. From the large number of characteristics we studied, only a minority appeared to be associated with children in the different subgroups: 1) only CAMH use, 2) only GP registered MHPs, and 3) both CAMH use and GP registered MHPs. In general, the children with GP registered MHPs more often had a history of medical conditions or consultations. The ones who were not yet recorded with CAMH use seemed to more often have typically age-specific registrations such as a difficult temperament and incontinence at primary school age or adverse parental and family factors in adolescence.

To our knowledge this is the first study that used a large population-based cohort with all available routine healthcare data from primary care that also linked this data on the individual patient level with data regarding CAMH use. This made it possible to obtain insight into the overlap between recorded MHPs in primary care and CAMH use, including the timeline between recorded MHPs by GPs and CAMH use.

We found that children with CAMH use without a GP recorded MHP in the same year were less likely to be overweight or to have a history of medical conditions such as somatic complaints, chronic diseases and medication or laboratory test results than with a GP recorded MHP. This might suggest that the children with only CAMH use could be less visible on the GP's radar, as registered somatic symptoms in children such as headache or abdominal pain have previously been described as risk factors for anxiety and depression based on GP records(37). In addition, primary school-aged children in the only CAMH use group also relatively had more registered school problems, which would suggest that referral to CAMH might have happened via schools. Their problems may reflect the psychosocial problems that a child encounters when entering the school setting. Preventive youth healthcare professionals often have a close link with the schools, to facilitate early recognition of problems in school(27).

In line with this, in this current study preventive youth healthcare concerns for MHPs in primary school-aged children, were more often found in the children with CAMH use but not in the group with GP recorded MHPs. Interestingly, the children with CAMH use without GP registered MHPs did not score particularly high on screening tools for MHPs,

and they less often had a lower secondary school level. It is known that adolescents with a higher educational level experience more stress. And this group of children with CAMH use without GP registered MHPs might concern these children who seek psychological counselling themselves. Or it might concern a group of children/parents that has been referred to as the 'worried-well', typically higher educated patients that fear symptoms or disease in the absence of pathology and who might have sought psychological counselling themselves(38, 39). It would be interesting to investigate further who the children with only CAMH use are and how and for what reasons these children were referred to CAMH. Future studies should therefore also aim to include data from the social domain, e.g. from social workers, as they might be involved in the care for these children.

We were also interested in whether certain characteristics would differentiate between children with GP registered MHPs who were or who were not also registered in CAMH. In primary school-aged children, having school problems or bullying/being bullied were risk factors for having both GP recorded MHPs and CAMH use, whereas these factors were not associated with only GP recorded MHPs. The presence of these characteristics could indicate more severe MHP symptoms, also affecting the daily social and academic functioning of the child and this could be a reason for a GP to refer a child to CAMH(40). These characteristics however were not associated with both GP recorded MHPs and CAMH use in secondary school-aged children. A possible explanation for this finding might be that in adolescence more girls are reported to have MHPs with relatively more internalizing problems, possibly resulting in somatic symptoms, as opposed to boys in primary school with a higher prevalence of externalizing problems.

In secondary school-aged children being overweight was protective for the outcome both GP recorded MHPs and CAMH use, while being underweight was a risk factor for this outcome. Being underweight might indicate problems with eating such as anorexia nervosa or bulimia. The incidence of eating disorders rises in adolescence and these kinds of problems are typically not being treated by GPs so that children with these problems would be referred for additional professional help(41).

A limitation of this study was the quality of the available data. As more extensively described elsewhere, over half of the characteristics based on information from preventive youth healthcare had more than 50% missing data and the prevalence of characteristics like family history of MHPs was lower than expected from the literature(42). Although electronic health records (EHRs) have the advantage of providing larger quantities of real-life clinical data than are available from scientific studies, the quality of this data raises important considerations(43). This is mainly the result of the

fact that these data were primarily used for providing healthcare, not scientific research. One of the major challenges of using EHR data for research is the presence of missing data, which are often missing not at random(35, 43, 44). As our aim was to identify characteristics of children who use CAMH based on available information from EHRs, we chose not to impute. However, missing data regarding determinants registered with data from preventive youth healthcare might have led to an underestimation of the found associations.

In addition, the general practice data regarding referrals/contact with other healthcare professionals and specifically CAMH was not very detailed in our extracted database. We could for instance see that there had been contact with certain health professionals, but for the majority of contacts we could not see whether the mail was inbound or outbound. We don't expect this to have affected our outcomes in a substantial way.

Due to governmental policy changes, data regarding CAMH use were only available for the period between 2009 and 2014 and we could not exclude children with CAMH use before 2009. We aimed to study children with a first episode of MHPs. As the majority of children with CAMH use also had MHPs registered by GPs, these children would have been excluded based on the presence of MHPs registered by GPs before 2009. However, the small group of children with only CAMH use before 2009 and no GP recorded MHPs might incorrectly not have been excluded from our study population. As it concerns a small group, we don't expect this to have altered our findings in a substantial manner. In addition, it is known from literature that not all children in need of CAMH receive CAMH(11, 12). Due to the nature of our data, we could not investigate these children.

This study showed that over six percent of children used CAMH without the GP having recorded MHPs and that these children in general less often had registered somatic or chronic diseases. Those children might be less visible in general practice and we would recommend future studies to investigate further who these children are and how they ended up using CAMH and for what reasons. In addition, we know from qualitative research that Dutch GPs currently have no structural interactions with preventive youth healthcare professionals other than occasional referral letters and that both professionals feel the need of better information exchange(45). As preventive youth healthcare concerns for MHPs were a risk factor for CAMH use and/or GP recorded MHPs, our study suggests that better information exchange between preventive youth healthcare and general practice could be useful in the identification of children who might need CAMH. It should be investigated whether this information is indeed what GPs need and how this structural information exchange practically can be executed.

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Supplementary Files

Supplement Table 1. Outcome definition

MHP based on the presence of ≥1 of the following:	Description
MHP ICPC code	P01 Feeling anxious P02 Acute stress reaction P03 Feeling depressed P04Feeling/behaving irritable P05 Senility, feeling/behaving old P06 Sleep disturbance P07 Sexual desire reduced P08 Sexual fulfilment reduced P09 Sexual preference concern P10 Stammering/stuttering/ tic P11 Eating problem in child P12 Bedwetting/enuresis P13 Encopresis/ bowel training problem P15 Chronic alcohol abuse P16 Acute alcohol abuse P17 Tobacco abuse P18 Medication abuse P19 Drug abuse P20 Memory disturbance P21 P22 Child behaviour symptom P23 Adolescent behaviour symptom P24 Specific learning problem P25 Phase of life problem adult P27 Fear of mental disorder P28 Limited function P29 Psychological symptom other P71 Organic psychosis other P72 Schizophrenia P73 Affective psychosis P74 Anxiety disorder/anxiety state P75 Somatization disorder P76 Depressive disorder P77 Suicide/suicide attempt P78 Neurasthenia/surmenage P79 Phobia/compulsive disorder P80 Personality disorder P81 Hyperkinetic disorder P82 post-traumatic stress disorder P85 Mental retardation P86 Anorexia nervosa/bulimia P98 Psychosis NOS/other P99 Psychological disorders, other T06 Anorexia/ bulimia
MHP ATC Code	N05A Antipsychotic drugs, N05B Anxiolytic drugs, N05C Hypnotics and sedative drugs, N06A Antidepressant drugs, N06BA02 dexamphetamine, N06BA04 methylphenidate N06BA09 atomoxetine N07BA drugs used in nicotine dependence or N07BB drugs used in alcohol dependence
MHP Referral to psychologist, psychiatry or psychotherapy	'eerste-lijnspsychologie' 'EERSTE-LIJPSYCHOLOGIE', 'GGZ-instelling', 'psychiatrie''PSYCHIATRIE' 'psychologische zorg' 'PSYCHOLOGISCHE ZORG' 'psychotherapie' 'PSYCHOTHERAPIE', 'ELP' 'ELP eerste-lijnspsyc' 'ggz' 'GGZ' 'PSL' 'PSL psychologische z' 'PSL Psycholoog' 'PST' 'PST' 'PSY' 'PSY psychiatrie' 'PSY' 'Psychiatrie' 'PTH' 'PTH psychotherapie'

MHP = mental health problem, ICPC = International Classification of Primary Care, ATC = Anatomical Therapeutic Chemical, a medication classification (29, 30)

Supplement Table 2. Definition of characteristics based on general practice data

Variable
Age
Gender
Medical condition
Congenital anomaly
Disabilities
Chronic Disease
Neoplasms

	Definition
	Age in years based on birth year
	Recorded as in EMR: male or female
	ICPC A90 Congenital anomaly OS/multiple, B78 Hereditary haemolytic anaemia, B79 Congenital anomaly Blood/lymph other, D81 Congenital anomaly digestive system, F81 Congenital anomaly eye other, H80 Congenital anomaly of ear, K73 Congenital anomaly cardiovascular, L82 Congenital anomaly musculoskeletal, N85 Congenital anomaly neurological, R89 Congenital anomaly respiratory, S81 Haemangioma/lymphangioma, S82 Naevus/mole, S83 Congenital skin anomaly other, T78 Thyroglossal duct/cyst, T80 Congenital anomaly endocrine/metabolic, U85 Congenital anomaly urinary tract, W76 Congenital anomaly complicate pregnancy, X83 Congenital anomaly genital female, Y82 Hypospadias, Y84 Congenital genital anomaly male other
	ICPC A28 Limited function/disability NOS; The remaining ICPC codes refer to the limited function/disability codes of the corresponding chapters B28, D28, F28, H28, K28, L28, N28, P28, R28, D28, T28, U28, X28, Y28, Z28,
	≥1 of the following: Asthma, Eczema, Psoriasis, Crohn, Inflammatory bowel disease IBD, Epilepsy, Diabetes Mellitus DM, Cystic Fibrosis CF, Rheumatoid Arthritis RA Asthma ICPC R96 ATC R03, Eczema/psoriasis ICPC S91 Psoriasis, IBD ICPC D94, S86 Dermatitis seborrhoeic S87 Dermatitis/atopic eczema S88 Dermatitis contact/allergic ATC D07 Dermatological corticosteroids, Epilepsy ICPC N88 ATC N03 anti-epileptics, DM ICPC T89 T90 ATC A10 drugs used in diabetes, CF T99.10, RA L88
	ICPC B75 Benign/unspecified neoplasm blood, D78 Neoplasm digest. benign/uncertain, F74 Neoplasm of eye/adnexa, H75 Neoplasm of ear, K72 Neoplasm cardiovascular, L71 Malignant neoplasm musculoskeletal N75 Benign neoplasm nervous system N76 Neoplasm nervous system unspecified, R86 Benign neoplasm respiratory, S78 Lipoma, S79 Neoplasm skin/benign/unspecified, S80 Solar keratosis/sunburn, T72 Benign neoplasm thyroid, T73 Neoplasm endocrine other/unspecified, U78 Benign neoplasm urinary tract, U79 Neoplasm urinary tract NOS, W73 Benign/unspecified. Neoplasm/pregnancy, X78 Fibromyoma uterus, X79 Benign neoplasm breast female, X80 benign neoplasm female genital, X81 genital neoplasm other/unspecified Y79 Benign/unspecified. Neoplasm gen. male, Y85 Benign prostatic hypertrophy, A79 Malignancy NOS, B72 Hodgkin's disease/lymphoma, B73 Leukaemia, B74 Malignant neoplasm blood other, B75 Benign/unspecified neoplasm blood, D74 Malignant neoplasm stomach, D75 Malignant neoplasm colon/rectum, D76 Malignant neoplasm pancreas, D77 Malignant neoplasm digest other/NOS, N74 Malignant neoplasm nervous system, R84 Malignant neoplasm bronchus/lunch, R85 Malignant neoplasm respiratory, other, S77 Malignant neoplasm skin, T71 Malignant neoplasm thyroid, U75 Malignant neoplasm of kidney, U76 Malignant neoplasm of bladder, U77 Malignant neoplasm urinary other, W72 Malignant neoplasm relate to pregnancy, X75 Malignant neoplasm cervix, X76 Malignant neoplasm breast female, X77 Malignant neoplasm genital other female, Y77 Malignant neoplasm prostate, Y78 Malignant neoplasm male genital other

Supplement Table 2. Continued

Variable
Prematurity/other perinatal morbidity
Lower socioeconomic status
Life events in past year
Academic problems
Difficult temperament
Developmental problem
Chronic somatic disorder parent
Somatic complaints

Healthcare use
Number of primary care visits in past year
Number of laboratory tests in past year
Number of medication prescripts in past year
Number of referrals/correspondences with other healthcare professionals (non-mental health)

MHP = mental health problem, ICPC = International Classification of Primary Care, ATC = Anatomical, Therapeutic Chemical, a medication classification(29, 30)

	Definition
	ICPC A93 Premature newborn, A94 Perinatal morbidity other
	Postcode marked as lower socioeconomic area: 0-20th percentile of Socioeconomic status (SES) score(46)
	ICPC Z15 Loss/death of partner problem, Z22 Illness problem parent/family, Z23 Loss/death parent/family problem, Z25 Assault/harmful event problem
	ICPC Z07 Education problem
	ICPC A14 Infantile colics, A15 Excessive crying infant, A16 Irritable Infant, T04 Feeding problem of infant/child
	ICPC T10 Growth delay, N19 Speech disorder
	No specific ICPC code, partly part of 'life event' with ICPC code Z22 Illness problem parent/family
	≥1 of the following: Tension headache, Migraine, Abdominal pain, Constipation, Tiredness, Irritable bowel syndrome IBS, Musculoskeletal symptoms, Dizziness, Nausea, Hyperventilation syndrome, Palpitations, Fainting. Tension headache ICPC N01 Headache N02 Tension headache, Migraine ICPC N89 ATC N02C, Abdominal pain ICPC D01 Abdominal pain/cramps general D06 Abdominal pain localized other, Constipation ICPC D12, ATC 06 Drugs for constipation, Tiredness ICPC A04 Weakness/ tiredness general. IBS ICPC D93, IBS ATC A03A Drugs for functional gastrointestinal disorders A03F Propulsives, Musculoskeletal symptoms ICPC symptom/complaint of: L01 Neck L02 Back L03 Lower back L08 L20 Joint, Dizziness ICPC H82 Vertiginous syndrome N17 Vertigo/ dizziness, Nausea ICPC D09 Nausea, Hyperventilation syndrome ICPC R98 Hyperventilation syndrome ICPC R86, Palpitations ICPC K04 palpitations K05 irregular heartbeat other, Fainting ICPC A06 Fainting/syncope

	Count per year
	Count per year
	Count per year
	Count per year

Supplement Table 3. Definition of characteristics based on preventive youth healthcare data

Variable	Definition[a]	Timing: first or last recorded measurement ≤T0
Concerns for MHPs (cMHPs)	-≥1 referral to a mental health specialist with indication mental health -≥1 consultation with a mental health specialist with indication mental health - Extra healthcare use in PYH between standard visits with indication mental health -≥1 intervention for mental health: -Triple P level 3 or higher and tip sheets (fears in children, stealing, dealing with fear or depression)(47) -Atypical mental health functioning (single examination in PYH) -≥1 abnormal specific mental health functioning recorded	First
Premature	Pregnancy duration <37 weeks or 259 days	First
Ethnicity	Immigrant/refugee Country of birth of ≥1 parent is other than the Netherlands or West-Europe (e.g. Suriname Dutch Antilles, Turkey, Morocco, Eastern Europe, other non-Western countries)	First
Nonspontaneous birth	Caesarean section, vaginal birth with forceps or vacuum extraction	First
Developmental problems	General developmental delay and/or speech and language delay at age 7 years and older	First
Incontinence	Incontinent for urine or faeces at age 4 years and older	Last
Sleeping problems	Sleeping problems	Last
Eating problem	Eating Problem	Last
Overweight	BMI classified as overweight or obese according to international age and gender specific standards(48, 49)	T0
Underweight	BMI classified as underweight according to international age and gender specific standards(48, 49)	T0
Negative weight perception	Negative perception of own weight (too light or too heavy)	T0

Supplement Table 3. Continued

Variable	Definition[a]	Timing: first or last recorded measurement ≤To
School problem	Any reported problems in school e.g. dyslexia, difficulty focusing, motivation problems, absenteeism or declining school performance	First
Secondary school level	Secondary school education level divided into 4 categories according to the Dutch school system: -low: VMBO or lower -middle: HAVO (reference category) -high: VWO -Other: in case of special education/no education; HAVO is reference category. When combined education levels were recorded, the lowest level was chosen, e.g. HAVO for HAVO/VWO	Last
Bullying/being bullied	Bullying or being bullied	First
Bad relationship with at least one parent	Bad relationship with at least one parent	Last
Low self-confidence/ resilience	Low self-confidence/ resilience	Last
Self-harm	Self-mutilation or suicidal thoughts	First
Female genital mutilation	Female genital mutilation	First
Unemployment or financial distress of the child	Unemployment or financial distress of the child	Last
Member of hobby of music club	Member of a hobby or music club	Last
Insufficient physical exercise	Less than one hour of exercise a day and/or not enough physical exercise according to the EMOVO[b] questionnaire: cycling or walking to school or an internship less than 1 day a week	Last

Supplement Table 3. Continued

Variable	Definition[a]	Timing: first or last recorded measurement ≤T0
Substance use	Alcohol use: at least once a week an alcoholic consumption	Last
	Drugs use: using or ever used hard drugs or soft drugs	Last
	Smoking: smoking or ever smoked	Last
	Water pipe use, at least once a week	Last
	Substance abuse/addiction (sum of the use of alcohol, drugs, smoking, waterpipe) and additional element	Last
Excessive Energy drink consumption	Energy drink abuse/addiction, consumes more than 1 energy drink a day	Last
High technology use	Gaming: more than 3 days a week	Last
	Social media use more than 3 days a week	Last
	Screen use on average daily over 2 hours of television or computer use	Last
SDQ borderline[c]	SDQ total score between normal and increased limits (borderline) -total score 3 years: 9-11 -total score 4-7 years: 11-14 -total score 8-14 years: 11-13 -total score 15-19 years: 13-15	Last
SDQ increased[c]	Increased SDQ total score -total score 3 years: 12-40 -total score 4-7 years: 15-40 -total score 8-14 years: 14-40 -total score 15-19 years:16-40	Last
KIVPA increased[d]	Increased KIVPA score ≥6 is an indication for consultation with PYHP. Maximum is 25 points	Last
Under treatment other than PYH	Already perceiving any form of treatment not in PYH	Last
Medical referral	Medical referral	until T0
Paramedical referral	Referral to speech therapist, dietician or physical therapist	until T0
Other referral	All referrals except medical or paramedical referrals, e.g. parenting support, home counselling, program for overweight children	until T0

Supplement Table 3. Continued

Variable	Definition[a]	Timing: first or last recorded measurement ≤To
Total referral by PYH	Sum of all above referrals	
Extra healthcare visit in PYH	Extra healthcare visit in preventive youth healthcare on top of standard visits, excluding visits for MHP and vaccinations	Until To
Life events	Looked after children (children who are (temporarily) in a foster family, living in an institution only when parents cannot take care of the child or custody by other person than family member	First
	Conflicts within household/hostile atmosphere	First
	Death of parent(s), sibling or another significant person.	First
	Victim of violence/abuse	First
	Divorce parent(s) or abandonment by parent	First
	Adoption	First
	Immigrant/refugee	First
Family history of MHP	Parents with any mental health problem	First
	Siblings with any mental health problem	First
Chronic illness parent	Parent with chronic illness	First
Risk factor parents	Parent victim of abuse in youth	Last
	Start of parenting support program "Stevig ouderschap", which helps parent(s) with a difficult start, for example due to the medical history of the parent or child, personal problems, insufficient supportive environment	Last
	Little support from social network parents	Last
	Unemployment or financial distress parents	Last
	Both parents with low level of completed education according to the International Standard Classification of Education(50): no, primary or lower secondary education	Last

Supplement Table 3. Continued

Variable	Definition[a]	Timing: first or last recorded measurement ≤T0
Prenatal risk factors	Substance abuse (smoking, alcohol or drugs) of the mother during pregnancy	First
	Young parenthood: 1 or more parent <20 years old at birth	First
	Complications during pregnancy (IVF/ICSI, blood loss in 1st or 2nd trimester, hypertension, diabetes)	First
	Medication use during pregnancy (all prescribed oral medication to mother during pregnancy)	First
Non-traditional family composition	All non-two parent family compositions, e.g. co-parent family composition, stepparent family composition	Last
Negative balance	Based on the model of Bakker(51) which combines different protective factors and risk factors for a child's healthy development on micro- meso- and macro level	Last
Little confidence parenting skills	Little confidence in parenting skills and/or parents with problems with parenting according to triple P multilevel program with level 3 or higher	First
Environmental stressors	Long hospital admittance child	Last
	Long hospital admittance sibling	Last
	Expansion in the family by sister, brother or stepparent, stepbrother or stepsister	Last
	Move/migration	Last
	Conflict outside of household	Last

[a]All definitions of the determinants are binary (yes/no). Information regarding developmental delay, incontinence, school problems including bullying, substance use, mental health problem (MHP) screening tools Strengths and difficulties questionnaire (SDQ) and short indicative questionnaire for psychosocial problems among adolescents (KIVPA), life events, family MHPs and parental educational level was available from the period 2005-2015. Information regarding the other predictors was available from the period 2010-2015. [b]EMOVO = a digital questionnaire of Dutch preventive youth healthcare (PYH) to monitor the health and well-being of second and fourth graders of secondary school(52). [s]Strengths and difficulties questionnaire (SDQ) = short screening questionnaire to screen for MHPs in children 2-17 years old(53). [d]KIVPA = a short indicative questionnaire for psychosocial problems among adolescents(54).