

COHORT PROFILE

Cohort Profile: The Quebec Longitudinal Study of Kindergarten Children (QLSKC)

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The Quebec Longitudinal Study of Kindergarten Children (QLSKC) is an ongoing population-based prospective longitudinal study presently spanning ages 6–29 years, designed to study the prevalence, risk factors, development and consequences of behavioural and emotional problems during elementary school. Kindergarten boys and girls attending French-speaking public schools in the Canadian province of Quebec during the 1986–87 and 1987–88 school years were included in the cohort: 2000 children representative of the population and 1017 children exhibiting disruptive behaviour problems. To date, 12 waves of data have been collected, and three generations of participants have been involved in the study (i.e. the study child, his parents and the first child of the study child). Information on demographics, psycho-social and lifestyle factors, child and family member characteristics (physical and mental health), and outcomes such as psychiatric diagnoses, delinquency or school diploma were assessed during three important developmental stages (childhood, adolescence and early adulthood). Blood samples were also collected in early adulthood for genetic analyses. Information on publications, available data and access to data can be found on the following website (<http://www.gripinfo.ca/Grip/Public/www/>).

Why was the cohort set up?

The Quebec Longitudinal Study of Kindergarten Children (QLSKC) was originally designed to study the prevalence of behaviour problems during the elementary school years using a developmental perspective. Children were assessed yearly by their parents and teachers to ascertain changes in behaviour problems and their association with environmental factors. Four major aims were defined: (i) to describe children's developmental trajectories of behaviour

problems from entry into kindergarten to adolescence, (ii) to identify kindergarten children at risk of behaviour problems over the course of their elementary school education, (iii) to identify protective factors that enable at-risk children to succeed in school and be socially well-adapted, (iv) to contribute to the development of prevention programmes for at-risk children.¹

The study is based on a cohort of 3017 children attending kindergarten in French-speaking state schools in the province of Quebec in the 1986–87

and 1987–88 school years. Children aged 6.0 ± 0.3 (\pm standard deviation) years at baseline were followed until adulthood, thus allowing for data collections during three important developmental stages: childhood, adolescence and early adulthood. During the first years of follow-up, information on environmental factors (e.g. stressful events, socio-economic factors, parenting practices) and child and family member characteristics (e.g. temperament, physical and mental health) were collected to explore their possible links with future development. Health, lifestyle and social adjustment outcomes were assessed during adolescence and early adulthood.

The QLSKC was initiated by a group of investigators led by two of the co-authors (R.E.T. and F.V.). This study and a previous prospective longitudinal study (the Montreal Longitudinal-Experimental Study^{2,3}) led to the creation of the Research Unit on Children's Psychosocial Maladjustment [Groupe de Recherche sur l'Inadaptation Psychosociale de l'enfant (GRIP)], a multidisciplinary group of researchers based in three universities (i.e. University of Montreal, Laval University, McGill University) located in the province of Quebec, in south-east Canada (Figure 1). At the time of study initiation in 1986, the Quebec population was 6.7 million (7.9 million in 2010)⁴ whereof nearly 20% was rural.⁵ French is the first language for nearly 80% of the population.⁶

This study was approved by the research ethics boards of the University of Montreal, McGill University and St-Justine Hospital.

Who is in the cohort?

Two samples were followed up in the QLSKC: (i) a sample of 2000 children (Sample R), created to ensure that a segment of the cohort would be representative of the children attending kindergarten in French-speaking state schools in the province of Quebec in the 1986–87 and 1987–88 school years, (ii) a sample of 1017 children exhibiting disruptive behaviours (Sample D), created to provide power in studies on the development and aetiology of severe behaviour problems. These two samples were constituted in the autumn of 1988 with children involved in previous studies aimed to assess the prevalence of behaviour problems in kindergarten during the two preceding school years (T1 and T2). During T1 (end of the kindergarten year) and T2, consent forms and questionnaires were sent to parents and teachers of 6397 children (3101 girls—48.5%—and 3296 boys, mean age = 6.0 ± 0.3 years) attending kindergarten in French-speaking state schools, selected by a random sampling procedure stratified by both administrative region (the province of Quebec contains 11 administrative regions) and school board size (small, medium and large). In the autumn of 1988, to ensure a good participation rate during the follow-up, 2000 children (sample R, 999 girls and 1001 boys) were selected

among the children who had parent ($N=4055$ —63.4%) and teacher ($N=4360$ —68.2%) ratings. A random sampling procedure stratified by administrative region, school board size and sex was used to select the R sample, thus representative of urban and rural settings and of all regions of Quebec. No difference was found concerning the size of the school board (χ^2 test, $P=0.251$) between the R sample and the remaining 4397 children (6397–2000). Sample D ($N=1017$, 424 girls and 593 boys) included all the remaining children who scored at the 80th percentile or higher (with sex-specific cut-offs determined using parent and teacher questionnaires from sample R) on a disruptive behaviour scale according to either the parent or teacher questionnaire. Table 1 shows that the two samples were significantly different on a number of family characteristics. For example, parents of sample D were younger at the birth of their first child, had less schooling and were more often separated or divorced.

How often have they been followed up?

To date, 12 data collections have been conducted over 24 years (1986–2010), and three generations of participants have been involved in the study (i.e. the study child, his parents and the study child's first child). Data on the participants were obtained via teacher and parent reports (97.8% the mother) yearly from age 6 to 8 years and 10 to 12 years (kindergarten to grade 6); via parent reports at age 13–19 years; and via the participants themselves at the ages 13–29 years data collections. Finally, data on the study child's first child were obtained via paper or web-based questionnaires rated by the participant (now a parent). Informed consent was obtained from the parents and/or the subject at each time of data collection. Tables 2 and 3 present an overview of the age and the type of information that was collected at each measurement occasion involving the entire cohort (Table 2) or subsamples (Table 3).

What has been measured?

The type and content of the main measures of the QLSKC are presented in Tables 2 and 3. From ages 6 (T1) to 12 (T6) years, self-administered questionnaires were sent in the spring of each year to the parents and teachers of the 3017 children involved in the two samples R and D. The Social Behaviour Questionnaire³ was completed every year by both teacher and parent to assess the behaviour of the child. The emotional climate for the child and his/her temperament were assessed by the parent in the first two waves of data assessment. Information concerning the child (perinatal information, sleep, life events during the previous year, school environment, puberty, etc.)



Figure 1 The province of Quebec, Canada (reproduced with the permission of Natural Resources Canada 2012, courtesy of the Atlas of Canada)

or his/her family (socio-demographic information, general health, etc.) was also collected during that period. At age 15 years (T7), all the children from sample R and 775 children from sample D (owing to budgetary constraints) and their parents were invited separately to undergo a structured psychiatric interview using the Diagnostic Interview Schedule for

Children (DISC) and to fill out questionnaires concerning their life habits and the family history of mental health problems. The last wave, aimed to collect data on all the subjects from samples R and D, took place when the subjects were ~22 years old (T8). The objectives were to retrospectively follow subjects' life events and habits since their 13th birthday, as

Table 1 Significant differences in characteristics between the representative sample (Sample R) and the sample of children exhibiting disruptive behaviours (Sample D) at baseline (P -value < 0.05, t -test or χ^2 -test, depending on variable type)

Characteristics assessed at baseline	Sample R $N = 2000$	Sample D $N = 1017$
Continuous variables: mean (standard deviation)		
Disruptive behaviour score ^a	6.8 (4.0)	9.9 (4.4)
Maternal age at birth of first child (years)	24.6 (3.9)	23.7 (4.0)
Paternal age at birth of first child (years)	26.9 (4.0)	26.4 (4.2)
Maternal education (years of schooling)	11.9 (2.6)	11.2 (2.6)
Paternal education (years of schooling)	12.2 (3.4)	11.3 (3.3)
Categorical variables: Number (%)		
Sex of the child (boys)	1001 (50.1)	593 (58.3)
At least one parent speaks French	1949 (97.8)	965 (95.2)
Maternal employment	1014 (51.4)	454 (45.6)
Paternal employment	1655 (92.8)	786 (88.7)
Intact family unit	1660 (83.8)	743 (74.4)

^aSum of the mother's responses to the disruptive behaviour scale.
 N = sample size.

well as to collect blood and saliva samples for genetic analyses. Table 4 presents the 43 genes genotyped.

Data collected on subsamples are presented in Table 3. At age 13 years (grade 7), adolescents who attended a school where there were at least six other study participants were invited to self-report their delinquent behaviours via paper and pencil questionnaires. When the participants were 19 years old, information on the familial determinants of the young adults' psychosocial adjustment (activities, feelings, relationships and behaviours) was collected. At age 29 years, data concerning gambling practices and the main dimensions previously assessed were collected on a subsample of subjects who had complete data from the 15 or 22 years waves. This last wave was the first opportunity to collect information on the first child of the 573 participants who were parents at that time. Six versions of the questionnaire were developed according to children's age group to assess various dimensions including pregnancy, health, sleep, behaviour, peer-relationships, childcare, school progress, parental attitudes and child environment. In addition, saliva samples were collected from 392 children for genetic analysis.

Finally, information was obtained from official records concerning high school graduation at 23 years (obtained from the Québec Ministry of Education) and criminality until 25 years (obtained from the archives of the juvenile court and the adult court).

What is the attrition like?

At the 22 years wave of data collection, which was the last one involving the whole samples R and D, 13 participants were deceased, 41 could not be contacted, 1078 could not be traced and 186 refused to

participate. The overall attrition rate was thus equal to 43.7% (Sample R: 42.1%, Sample D: 46.7%). Compared with non-respondents, the sample of respondents did not differ on paternal age at the birth of the first child and school board size, but statistically significant differences were found for the following characteristics assessed at baseline: respondents were more often girls, exhibited less disruptive behaviours, lived in an intact family unit and had parents who were more educated and more often employed. These results are presented separately for sample D and sample R in Table 5.

What has it found? Key findings and publications

Information obtained during this longitudinal study led to more than 100 peer reviewed journal articles. A complete list of these publications is available on the GRIP website (<http://www.gripinfo.ca/Grip/Public/www/>). Highlights are summarized below.

Externalized and internalized behaviour problems from childhood to adolescence and young adulthood

Trajectories of externalized (hyperactivity, impulsiveness, aggressiveness) and internalized (anxiety, withdrawal, inattention) symptomatology have been described throughout childhood and linked to both subsequent outcomes and psycho-social and environmental factors.⁷⁻¹⁴ Boys' and girls' conduct disorder during adolescence was shown to be associated with elementary school developmental profiles of aggression, opposition, hyperactivity, fearfulness and helpfulness.^{15,16} Girls' hyperactivity and physical aggression during

Table 2 Summary of data collected on the participant (subject), his/her teacher (teacher) and his/her family (family, mother, father) at the eight measurements (T1–T8) involving the whole representative sample and sample of children exhibiting disruptive behaviours in the Quebec Longitudinal Study of Kindergarten Children

	6	7	8	10	11	12	15	22
Approximate age (years)	T1	T2	T3	T4	T5	T6	T7	T8
Measurement occasion	3009	2402	2624	2685	2708	2585	1694	1699
Sample size								
Self-administered questionnaires (informants: P-parent, T-teacher, S-subject)								
Self-Rating Questionnaire ^a (P, T, S)	Subject Family	Subject Family	Subject Family	Subject Family	Subject Family	Subject Family	Subject Family	Subject Family
Social Behaviour Questionnaire (P, T)	Subject	Subject	Subject	Subject	Subject	Subject		
Dimensions of Temperament Survey (P)	Subject	Subject						
Emotional Climate for Children Questionnaire (P)	Subject							
Teaching attitude (T)	Teacher	Teacher						
Pubertal Development Scale (P, S)				Subject	Subject	Subject		
Interviews								
Calendar of life events and habits								Subject
Family history							Family	
Diagnostic Interview Schedule for Adults							Mother	Subject
Diagnostic Interview Schedule for Children							Father	
Personality ^b							Subject	Subject
Suicidal Intent Scale and Scale for Suicidal Ideation								Subject
Administrative data								
Delinquency (juvenile courts, 13–17 years)								Subject
Judicial records (18–25 years)								Subject
High-school graduation (Quebec Ministry of education)								Subject
Blood sample (subsample, N = 1241)								Subject
Saliva sample (subsample, N = 479)								Subject

^aThe Self-Rating Questionnaire was adapted to the informant and the developmental stage of the child at each wave of data collection. The main information collected concerns:

- Socio-demographic information, neighbourhood, child care experience before 5 years of age, school environment and progress, activities and jobs.
- General health, drugs and medical services use, perinatal information, growth, laterality, sleep and nightmares.
- Alcohol and drug use, gambling, violence, delinquency and legal issues.
- Professional services use for affective/behavioural disorders, suicide attempts and ideas.
- Physical and sexual abuse, life events during the previous year.
- Family, friend and romantic relationships.

^bPersonality: Dimensional Assessment of Personality Basic Questionnaire (DAPP-BQ) and Big Five Inventory.

Table 3 Main data collected at the three measurement occasions involving subsamples of the Quebec Longitudinal Study of Kindergarten Children

Measurement occasion	Measures
13 years Informants: subject, parent 2014 selected subjects 1034 respondents	Self-Rating Questionnaire: <ul style="list-style-type: none"> • Socio-demographic information on the subject and his/her family: age, sex, education, employment, ethnicity, religion, family structure • Parents characteristics: height, weight, general health, alcohol and tobacco consumption, parental practices • Subject characteristics: height, weight and general health; alcohol, tobacco and drug consumption; gambling; delinquency and violence; family, friend and romantic relationships; activities and jobs; sexuality; school environment and progress Social Behaviour Questionnaire Pubertal Development scale Child depression Inventory Self-description questionnaire
19 years Informant: subject 1805 selected subjects 1240 respondents	Self-Rating Questionnaire <ul style="list-style-type: none"> • Family structure, parental practices • Family, friend and romantic relationships • School environment and progress • Activities and jobs • Behaviours and emotions Diagnostic and Statistical manual of Mental Disorders—4th edition, shortened form
29 years Informant: subject 1933 selected subjects 1370 respondents and 573 respondents' first child assessments	Self-Rating Questionnaire: <ul style="list-style-type: none"> • Subject characteristics: education, activities, neighbourhood, employment and income; family, friendly and romantic relationships; sexuality; parental practices, general health; alcohol, tobacco and drug consumption; gambling; criminality • Subject's first child assessment: pregnancy, pre and postnatal environment, general health, sleep, activities, peer-relationships, school environment and progress, child care experience and family environment Self-description questionnaire Diagnostic and Statistical manual of Mental Disorders—4th edition, shortened form Calendar of life events and habits Social Behaviour Questionnaire (subject's first child) Dimensions of Temperament Survey (subject's first child) Pubertal Development Scale (subject's first child) Saliva sample (subject's first child, $N = 392$)

Table 4 Genes genotyped in the 1241 blood samples collected at the 22 years measurement occasion in the Quebec Longitudinal Study of Kindergarten Children

Symbol	Human gene name
ADRA2A	Adrenergic, α -2A-, receptor
ADRB1	Adrenergic, β -1-, receptor
BDNF	Brain-derived neurotrophic factor
COMT	Catechol-O-methyltransferase
GABARAP	γ -Aminobutyric acid (GABA) A receptor-associated protein
GABRA1	γ -Aminobutyric acid (GABA) A receptor, α 1
GABRA4	γ -Aminobutyric acid (GABA) A receptor, α 4
GABRB1	γ -Aminobutyric acid (GABA) A receptor, β 1
GABRB3	γ -Aminobutyric acid (GABA) A receptor, β 3
GABRG1	γ -Aminobutyric acid (GABA) A receptor, γ 1
GABRG2	γ -Aminobutyric acid (GABA) A receptor, γ 2
GABRR1	γ -Aminobutyric acid (GABA) A receptor, ρ 1
GAD1	Glutamate decarboxylase 1
GLS	Glutaminase
GLUL	Glutamate-ammonia ligase
GRIA1	Glutamate receptor, ionotropic, AMPA 1
GRIA2	Glutamate receptor, ionotropic, AMPA 2
GRIA4	Glutamate receptor, ionotropic, AMPA 4
GRINA	Glutamate receptor, ionotropic, <i>N</i> -methyl <i>D</i> -aspartate-associated protein 1
GRINL1A	Glutamate receptor, ionotropic, <i>N</i> -methyl <i>D</i> -aspartate-like 1A
GRM3	Glutamate receptor, metabotropic 3
HTR1A	5-Hydroxytryptamine (serotonin) receptor 1A, G protein-coupled
HTR2A	5-Hydroxytryptamine (serotonin) receptor 2A, G protein-coupled
HTR2C	5-Hydroxytryptamine (serotonin) receptor 2C, G protein-coupled
HTR5A	5-Hydroxytryptamine (serotonin) receptor 5A, G protein-coupled
HTR6	5-Hydroxytryptamine (serotonin) receptor 6, G protein-coupled
HTR7	5-Hydroxytryptamine (serotonin) receptor 7, adenylate cyclase-coupled
MAOA	Monoamine oxidase A
MAOB	Monoamine oxidase B
NGFR	Nerve growth factor receptor
NOTCH4	Notch 4
NTF3	Neurotrophin 3
NTRK2	Neurotrophic tyrosine kinase, receptor, type 2
OATL1	Ornithine aminotransferase-like 1
SAT	Spermidine/spermine N1-acetyltransferase
SLC6A2	Solute carrier family 6 (neurotransmitter transporter, noradrenalin), member 2
SLC6A4	Solute carrier family 6 (neurotransmitter transporter, serotonin), member 4
SMOX	Spermine oxidase
SMS	Spermine synthase
SOX9	SRY (sex determining region Y)-box 9
TH	Tyrosine hydroxylase
TPH1	Tryptophan hydroxylase 1
TPH2	Tryptophan hydroxylase 2

Table 5 Significant differences between respondents and non-respondents at the 22 years wave of data collection on main baseline characteristics in the representative sample (Sample R) and the sample of children exhibiting disruptive behaviours (Sample D)

Characteristics assessed at baseline	Sample R			Sample D		
	N = 2000		P-value ^a	N = 1017		P-value ^a
	Respondents N = 1157	Non-respondents N = 843		Respondents N = 542	Non-respondents N = 475	
Continuous variables: mean (SD)						
Disruptive behaviour score ^b	6.6 (3.9)	7.1 (4.1)	0.013	9.9 (4.4)	10.0 (4.3)	>0.05
Maternal age at birth of first child (years)	24.9 (3.9)	24.2 (3.8)	<0.001	24.0 (4.0)	23.4 (4.0)	0.05
Paternal age at birth of first child (years)	26.9 (4.0)	26.9 (4.1)	>0.05	26.5 (4.2)	26.3 (4.2)	>0.05
Maternal education (years of schooling)	12.3 (2.6)	11.4 (2.6)	<0.001	11.6 (2.6)	10.8 (2.6)	<0.001
Paternal education (years of schooling)	12.6 (3.4)	11.5 (3.3)	<0.001	11.6 (3.2)	10.9 (3.4)	0.002
Categorical variables: number (%)						
Sex of the child (boys)	506 (43.7)	495 (58.7)	<0.001	269 (49.6)	324 (68.2)	<0.001
At least one parent speaks French	1139 (98.4)	810 (96.9)	0.02	524 (96.7)	441 (93.4)	0.016
Maternal employment	626 (54.5)	388 (47.1)	0.001	254 (47.4)	200 (43.6)	>0.05
Paternal employment	995 (94.2)	660 (90.8)	0.006	436 (90.5)	350 (86.6)	>0.05
Intact family unit	984 (85.6)	676 (81.2)	0.021	423 (78.6)	320 (69.4)	0.003
Size of school board						
Small (<300 children)	201 (17.4)	194 (23.0)	0.001	54 (10.0)	46 (9.7)	>0.05
Medium (300–700 children)	378 (32.7)	287 (34.0)		231 (42.6)	174 (36.6)	
Large (>700 children)	578 (49.9)	362 (42.9)		257 (47.4)	255 (53.7)	

^at-test or χ^2 -test depending on variable type.

^bSum of the mother's responses to the disruptive behaviour scale.

N = sample size. Bold text signifies significant differences ($P < 0.05$).

childhood were shown to be linked with many adjustment problems in early adulthood¹⁷: nicotine use, psychological and physical aggression in intimate partner relationships, low education, early pregnancy and welfare assistance. The study of the developmental trajectories of hyperactivity and inattention during childhood showed that inattention, rather than hyperactivity, predicted long-term educational attainment.¹⁸ This finding suggests that preventive interventions for school failure should target elementary school children with attention problems rather than hyperactive children without attention problems.

Sleep disturbances

Data were collected on sleep quality during childhood and adolescence to study the development of disturbing dreams and parasomnias. A sex difference has been identified, with a higher prevalence of disturbing dreams in girls and of enuresis in boys. An association of these problems was found with high anxiety but not with socio-demographic variables.^{19,20} Sleep patterns were also studied in relation to sex and puberty²¹ and to body mass index.²² The latter study reported that a short sleep trajectory (≤ 10 hr per night) during adolescence was associated with an

increased odds ratio of being in the overweight or obese body mass index trajectory compared with a long sleep trajectory (11 h per night).

Suicidal behaviours

Several articles using the data collected in the QLSKC on suicidal thoughts and attempts have been published. The main findings concern the correlates of suicide attempts among those with suicidal ideations (axis I psychopathology, female sex and childhood sexual abuse^{23,24}) and the prevalence of non-fatal suicidal behaviours in adolescent and young adults.²⁵ One study reported that developmental trajectories of anxiety and disruptiveness (aggression and physical aggression) during elementary school predicted suicide attempts during early adulthood. Anxious-disruptive girls and disruptive boys were more likely than their peers to have made suicide attempts by early adulthood.²⁶ Genetic data led to a gene-environment study investigating the differences and similarities in the serotonergic diathesis for suicide attempts and mood disorders. Five genes showed effects on suicide attempts and mood disorders. These occurred through different mechanisms, some of which involved gene-environment

interactions with the history of childhood sexual or physical abuse.²⁷

Psychoactive substances use and addictions

Prevalence of illegal drug use in adolescence was estimated,²⁸ and its association with behaviour and mood disorders was described.²⁹ Substance use was also shown to be associated with subsequent theft and violence, but not gambling.³⁰ A particular attention was given to gambling, especially to the potential consequences that parents' gambling may have on their children.^{31,32} Moreover, an extensive gambling assessment was conducted at the 29 years data collection (2010–11) to examine its association with the participants' children's behaviour.

Methodological issues

Many methodological articles have been published on the psychometric qualities of the behaviour ratings by mothers and teachers.^{33–38} Informant effect or agreement was also one of the main subjects of the methodological articles.^{39–41}

What are the main strengths and weaknesses?

The QLSKC cohort has many strengths, including its representativeness, the large scope of domains assessed, the frequency of assessments and the length of follow-up. It also has a relatively large sample size and low attrition rate, given that it is a representative cohort study of children followed from school entry to adulthood. The recent focus on the children of children followed since kindergarten has added fundamental information that may help to elucidate the intergenerational transmission of risks for various mental health disorders. Moreover, genotyping has enabled investigation of gene–environment interactions from a developmental perspective with rich environmental information. As with many longitudinal studies of children, particularly those with a similar length of follow-up, one of this study's weaknesses is the attrition rate during the last waves of data collection. However, as sample sizes are still large enough to obtain sufficient power for the desired statistical analyses, the biggest limitation resulting from these attrition rates concerns the representativeness of the respondents. Despite a

large number of retention methods used in the QLSKC, the attrition rate was 43.7% at age 22 years and respondents differed from non-respondents on several socio-demographic characteristics. As baseline socio-demographic information was well recorded in the QLSKC, certain statistical methods, such as observational weights, are available to limit this selection bias. Moreover, modern imputation methods have become a very useful tool to handle missing data and to limit its consequences on parameter estimations.

Another limitation concerns the retrospective information obtained from the mothers on the experiences and environment of their child before the first data collection at age 6 years. For this reason, the GRIP initiated a birth cohort involving 2000 newborns representative of births in the province of Quebec: The Quebec Longitudinal Study of Child Development (QLSCD).

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

The procedure to access the data is described on the GRIP website (<http://www.gripinfo.ca/Grip/Public/www/>) in the Research Program—Access to data section.

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KEY MESSAGES

- Behaviour problems during kindergarten predicted high-school completion by early adulthood.⁴²
- Developmental trajectories of several behavioural and emotional problems during middle childhood predicted different forms of adjustment problems during adolescence and adulthood.^{15–18}
- History of childhood sexual or physical abuse was found to interact with serotonergic genes in the prediction of suicide attempts and mood disorders in early adulthood.²⁷

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