Faculté des sciences

Mapping of walker's route and the exposure to ticks bites in a forest environment.

Author : Couck Martin
Supervisers : Vanwambeke Sophie, Rousseau Raphaël
Readers : De Keersmaecker Marie-Laurence
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Contents

1 Introduction

Zoonoses are defined like diseases that came from animals end can be transmitted to human. These kind of diseases can spread quickly and cause an high morbidity in urban, peri-urban and rural areas (INRAE, 2022).

The tick is one of the species most responsible for transmitting these zoonoses just after the mosquito (Sciensano 2021). Ticks are know to transmit diseases like anaplasmosis, babesiosis, tularemia, Mediterranean fever (boutonneuse fever), rickettsiosis or the most known one, the Lyme borreliosis (Tomalak et al., 2011).

Lyme disease, or also called Lyme borreliosis, is a zoonotic bacterial disease, caused by Borrelia burgdorferi sensu lato. Symptoms of the disease can be heart or lung problems but can also inflict joint damage as well as neurological damage that can lead to partial paralysis (Strle and Stanek, 2009).

The most widespread specie of tick in Europe is *Ixodes ricinus* which is the principal contributor to the spread of the Lyme Borreliosis (Estrada-Peña, 2014). Ticks are mainly found in green areas such as gardens, parks, fields and forests and feed on a large variety of species like mammals, birds, cervids and even some reptiles (Killpatrick et al., 2017: Fletcher Baines, 2017 ; Gray, 1998).

Climatic and environmental factors influence the transmission vectors of the tick-borne diseases by acting on the number of specimens as well as the infection rate. Whereas the human exposition depend on human factors, urban and peri-urban forests are important to consider because of their attractiveness and their tick population (Estrada-Peña, 2015; Rousseau et al., 2016).

The main objective of this study is to analyse the factors that influence the exposition and vulnerability to tick bites in the Bois de Lauzelle in the city of Louvain-La-Neuve, Belgium. We will especially be interested in the relationships between experiences and knowledge about ticks and the adoption of risky behaviors like the non-use of prevention measures or walking in risk areas. With this study we will also be able to look at the frequentation of the forests routes and the riskiness of the latter thanks to a map. The main hypothesis is to see if knowledge really helps to prevent tick bites and what behaviors can explain the risk taking.

The first part will be a review of the global context and the studies that have already been made. The next part will present and detail the method that has been used to analyse the data. The third part will display the results of all the analysis made and finally a discussion will help to understand what emerges from it and how to use it.

2 Context

2.1 Ticks : *Ixodes ricinus*

The tick is a hematophagous arachnoid arthropod generally represented in two families: hard ticks (*Ixodidae*) and soft ticks (*Argasidae*) (Gray, 1998; Tomalak et al., 2011). The two of them present several differences: (*Argasidae*) lives in sheltered environments, like nests, caves, etc., while (*Ixodidae*) are, for the most of them, in more opened environments. They also differentiate by their way of seeking an host and when. Hard ticks have a seasonal activity and mostly non-nidicolous contrary to soft ticks. Another important difference is the way that they feed. (*Argasidae*) only stay several minutes or hours to its host whereas (*Ixodidae*) will stay several days firmly attached (Parola and Raoult, 2001; Tomalak et al., 2011).

Ixodes ricinus is part of the *Ixodidae* family. This family includes more than 600 species but *I. ricinus* is the most represented in western Europe. *I. ricinus* is a hard tick given its sclerified dorsal shield (Tomalak et al., 2011). Another difference between hard and soft ticks is how long the tick eats. *I. ricinus* will tend to cling to its prey, feed on its blood for several days, detach and then grow to the next stage, whereas the meal of a soft tick rarely lasts more than half a hour (Parola and Raoult, 2001; Tomalak et al., 2011).

The lifespan of the male *I. ricinus* varies between two and three years but can vary depending on environmental conditions, like a temperature between 7 and 35°C (James et al., 2012), to be reduced to six months or, on the contrary, extended to six years (Parola and Raoult, 2001). The female reproduces after her meal on the host, detaches, lays her eggs and dies just after (Figure 1) (Parola and Raoult, 2001).

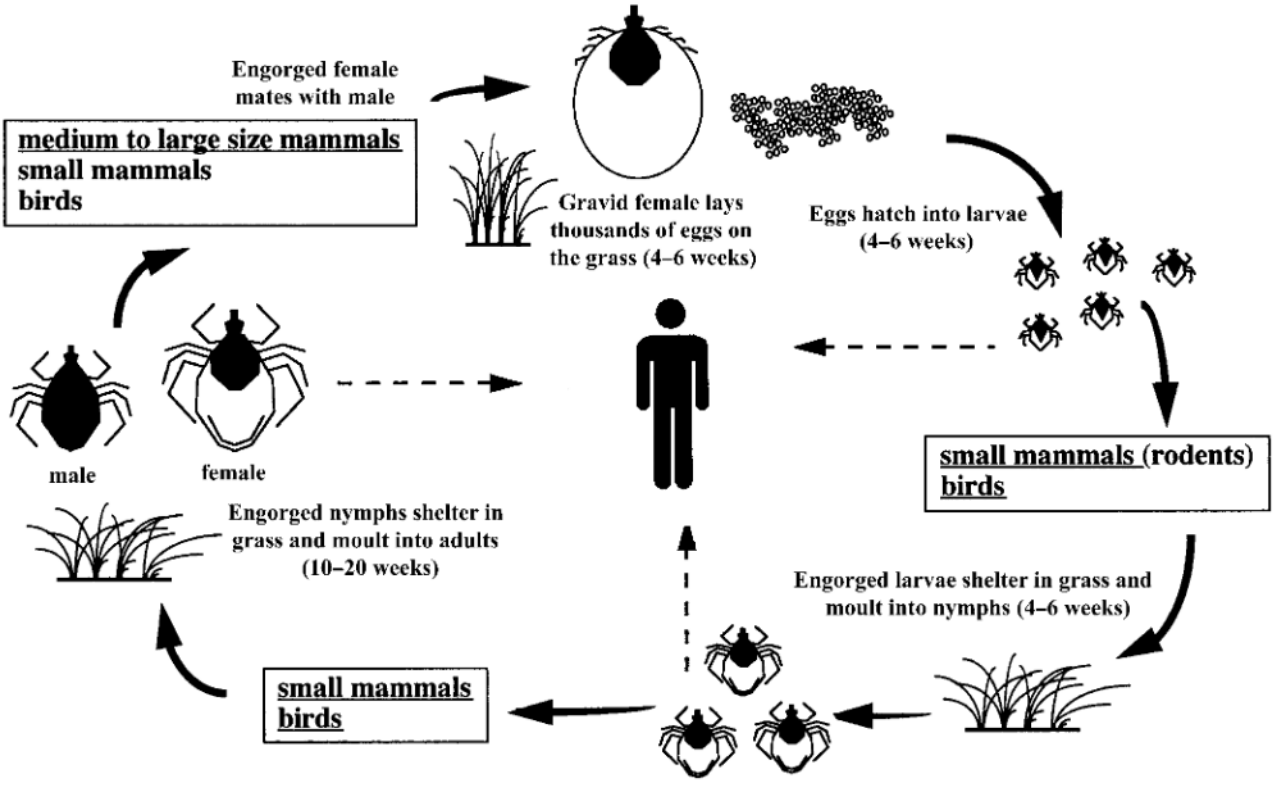

Figure 1: Life cycle of a tick (Parola and Raoult, 2001)

Ixodes ricinus goes through four different life stages: egg, larva, nymph and adult. During their active stages (nymph or adult), the tick will attack its host by hiding in the vegetation and

catch the host when it comes into contact with it (Tomalak et al., 2011 ; Gray, 1998). At the nymph level, the tick prefers to cling on smaller animals like birds, rabbits or mouses. Sometimes it grabs something bigger like cows or sheeps. The adult one prefers larger mammals like deer, bovines and human (Fletcher Baines, 2017 ; Killpatrick et al., 2017; Gray, 1998).

By feeding from one host to another, ticks can acquire or catch many pathogens, microbes and other viruses that can be transmitted to the next host afterwards. A study conducted in the Saint Petersburg region revealed that of 1606 passerines examined, 110 (6.8%) were found to be infested with larvae and/or nymphs of *I.ricinus* (Alekseev and Dubinina 2003). Of these 110, 51.8% contained one or more human pathogens, such as tick-borne encephalitis virus, *Borellia* spp, *Rickettsia* spp, *Anaplasma* spp or *Babesia* spp.

Ixodes ricinus is among the most widespread species of ticks in Europe but the distribution of their population varies according to climatic conditions such as seasons differences or climatic changes. They also depend a lot on the level/type of vegetation and the density of hosts available (Estrada-Peña, 2014).

2.2 Lyme borreliosis (LB) and other tick-borne diseases (TBD)

Lyme disease, or also called Lyme borreliosis, is a zoonotic bacterial disease, caused by *Borrelia burgdorferi* sensu lato. It was discovered in the Old Lyme town, Connecticut, in 1975 but traces of it were found since 18th century (Parola and Raoult, 2001; Sciensano, 2022). The first three species of *Borrelia* known to cause Lyme disease were discovered in 1982. They are *Borrelia burgdorferi* sensu stricto, *Borrelia afzelii* and *Borellia garinii* (Tomalak et al., 2011; Stanek and Reiter, 2011). *B. afzelii* is supposed to be associated to rodents, *B. garinii* circulates in avian reservoirs host and *B. burgdorferi* is more polyvalent (Estrada-Peña, 2014; Parola and Raoult, 2001).

Symptoms of the disease can show up in the form of heart or lung problems but can also inflict joint damage as well as neurological damage that can lead to partial paralysis depending on the phases (Strle and Stanek, 2009). The first phase consists of a chance (+- 80%) of getting skin infection in the form of erythema. A fever can also appear depending on the case. The second phase takes place a few months after contamination and presents itself in the form of neurological and/or rheumatological disorders. The third phase accentuates the symptoms of the second and leads to severe forms of arthritis, skin atrophy or even cognitive, motor or neurological problems. The disease is therefore not very dangerous if treated early with antibiotics (Schoen, 2020; Chomel, 2015; Russel et al., 2018).

According to Sciensano (2022), more than 2000 positive results for Borrelia were reported in Belgium in 2014, where approximately 10% of ticks are infected. Among these cases, it was estimated that about 200 to 300 people are hospitalised every year for a Lyme borreliosis. The number in higher that the previous years, where it was about 1000-1500 cases a year, because the number of serological tests has gone up too. In France, more than 60 000 cases were reported in 2020 for an average of 800 hospitalisations per year (SantépubliqueFrance.fr, 2022).

Except the *Borrelia spp*, there are three other pathogens that are present in Belgium: *Rickettsiae helvetica* (14.1%), *Anaplasma phagocytophilum* (19.5%) and *Babesia spp* (1.3%) (Claerebout et al., 2013; Obsomer et al., 2013). The first one can cause fevers, muscle aches or headaches as well as erythema migrans (Lindblom et al., 2013). The second one can cause also fevers, joint pain and chills (Petri, 2020) and the third one has a majority of bitten people without symptoms but sometimes can cause headache, chills, nausea, cough and joint pain (Pearson, 2020).

2.3 Prevention and protection

2.3.1 Ways of protection

To avoid the transmission of these diseases as much as possible, prevention must play an important role in order to inform walkers about the ways of protection. Among them, there is the conditions of clothing for example, that is to say the fact of exposing your skin as little as possible to the external environment in a risky area. A Scandinavian study showed that more than 35% of walkers used at least three ways of prevention in risk areas, whether clothing or repellents, while almost 20% never used any (Jespen et al., 2019). In Finland, 81% of respondents are aware of ways of clothing protection (Zoldi et al., 2017). Furthermore, in Sweden, 64% of the respondents wear the right clothes when they go on a walk and that 16% use the combination pants in socks (Slunge et al., 2018).

Repulsives are also an efficient method of protection, but in Finland, only 14% believe in the effectiveness of the repellents (Zoldi et al., 2017). By comparison, in the USA, nearly 30% use repellent in risk areas (Jones et al., 2002), and in Sweden, this number goes down to 16% (Slunge et al., 2018).

Bodychecking is also part of the prevention, the sooner the tick is removed, the less the chances are of contracting a disease. Under 24h the risk is weak but over 72h there could be high chances of infection. (Tomalak et al., 2011; INRAE, 2020). In the USA, 54% of walkers affirm that they check their body after a walk (Jones et al., 2002), in Sweden that number goes up to 63% (Slunge et al., 2018) and for the entire Scandinavia the stats are over 50% (Jespen et al., 2019).

The Swedish study concluded that Swedish people are enough aware of the danger that can be encountered. This awareness exists because 83% of them go in the forest at least once a month and 31% of them have already experienced a tick bite in the last year while 68% report at least one during a lifetime (Slunge et al., 2018). Furthermore, 48% try also to avoid risky areas (Slunge et al., 2018).

The ideal method to remove ticks is the use of tick tweezers and a magnifying glass for the immature ones. These tools help grabing the mouthparts of the ticks as close as possible to the skin, the tick must then be pulled, perpendicular to the skin (Parola and Raoult, 2001; Claerebout et al., 2013). After removing the tick, it is important to use a disinfectant to clear the wound. The use of fingers, cigarette burns or oil should be avoided because it can cause regurgitation from the tick and increase the risk of infection and transmission (Parola and Raoult, 2001).

The perfect prevention method is described like this: Stay in marked areas and wear long pants put in socks while checking the body after every walk (Parola and Raoult, 2001; (Figoni et al., 2019). The ideal would be to apply some topical DEET (N,N-Diethyl-meta-toluamide) which is known to be the most effective insect repulsive since its discovery in 1944 (Figoni et al., 2019; Pages et al. 2014; Parola and Raoult, 2001). Effectiveness is 100% on the applied area if its concentration stays between 15 and 33%. It can sometimes cause itching but nothing serious. This product is used by the US military and other organisations, armies because of its effectiveness against not only ticks but also flies, mosquitoes and fleas (Figoni et al., 2019; Pages et al. 2014).

Topical DEET is effective but considered not enough if full protection is wanted. Apply the product on only the exposed skin can sometimes cause the tick to crawl somewhere else safe on the body. Using permethrin on wearing clothes will complete the protection to avoid ticks to go anywhere on the body. Permethrin is a insecticide and a medication used mostly to treat lices but also other insects. It is marked as one of the "Essentials medicine" by the WHO since 2013

(Parola and Raoult, 2001, World Health Organisation, 2022) .

2.3.2 Prevention level

Not everyone uses prevention measures to the same extent. It is sometimes difficult to realize what information we need to be the most protected and how to find it.

In France, for example, one of the easiest ways to find informations on prevention is by asking the pharmacist. A large part of them are perfectly aware of the risks and how to avoid them but they have a lack of information on the tick ecology, which can lead to difficulties in spreading relevant information about tick risk (Bord et al., 2022).

In Canada, prevention campaigns are effective but heterogeneous depending on the region. It was noticed over time that the level of prevention increase more in the less risky areas of the country after diffusions of multiple campaigns (Aenishaenslin et al., 2016). In 2014, 12% of the respondent where not aware of the existence of the Lyme disease, this number goes up to 35% in France in 2016 (SantépubliqueFrance.fr, 2022), and 50% of those who knew it take preventive measures. The same study wanted to judge the adoption of preventive behaviours and the exposure to bites of Canadians and showed that the level of prevention is higher when people have knowledge about the risks, when they live in a rural area and when they already experienced bites (Aenishaenslin et al., 2017).

The prevention of Lyme borreliosis should rather focus on reducing the tick-human contact rate instead of attempting to increase the proportion of dilution hosts though the fact that the density of ticks is slowly affected by the dilution is still debated (Ruyts et al., 2018; Randolph and Dobson, 2012).

2.3.3 Exposition to tick bites

The prevention must also target different type of profiles depending on the age, situation or activity practiced. For example, a study was conducted in 2020 to see which are the activities that expose the most the practitioner. Jore et al. (2020) indicated that people were more exposed to tick bites during walking, running, gardening, paddle, rowing and that 60% of bites occurs on average on adults. It also state that rural and urban inhabitants should be prevented the same even if some knows more than others. In the end, it shows also that the possession of an animal is not associated with the risk of getting a tick bite (Jore et al., 2020).

2.3.4 Predicting the apparition of ticks

The probability of tick bite is dependent on the density of nymphs (DON). Predicting DON is challenging because it is still complicated to establish a precise patterns given that the variation in DON is still poorly understood. (Van Gestel et al., 2021). DON varies widely in the same types of habitat. Van Gestel et al. (2021) found values ranging from zero to 30 nymphs/m^2 (figure 2).

	Mean ± SD (Nymphs / m^2)	Min (Nymphs / m^2)	Max (Nymphs / m^2)
Across locations	0.62 ± 1.35		
Bench	0.30 ± 0.59	0	5.2
Trail	0.46 ± 0.77	0	7.4
Forest interior	0.98 ± 1.97	0	30

Figure 2: Observed densities of Ixodes ricinus nymphs per m2 at each location type in the Campine region in Belgium (Van Gestel et al., 2021)

Rousseau et al. (2016) also found that the variation between nymphs and adult ticks density are different. Results showed that it could vary from 2.12 to 14.59 nymphs/10m^2 and 0.24 to 1.29 adults/10m^2. However, it is suggested that ticks appear less frequently in places close to human infrastructure, the latter influencing the environmental conditions (soil, wind, temperature, etc.) necessary for the appearance of ticks (Van Gestel et al., 2021) . It also implied that they are less present when approaching the roads, but Van Gestel et al. (2021) adds that the risk remains omnipresent in forests nevertheless.

2.4 The impact of COVID-19 on forests visits

The outbreak of COVID-19 in 2020 brings with it a whole new set of walkers that wanted to take some fresh air during the lockdown (Derks et al., 2020). For exemple, in Germany, there's been a rise of 140% more walkers that came to forests (Derks et al., 2020). The increase began the 22th of March 2020 when the first limitations were taken. This new set of visitors was different that the ones who came before the lockdown. Here we have more young people, more families with childs and non local people who came to have a change of scene (Derks et al., 2020).

All of these new walkers worry forests keepers in Germany because of their lack of general knowledge about ecology. They want them to raise their awareness whether it is about ecology or at least about ensuring their protection (Derks et al., 2020). It is though uncertain if if the new wave of people will stay and if the flow of visitors will keep the same socio-economic characteristics after the pandemic (Derks et al., 2020).

Another example is in the US where the number of walkers in forests has doubled during the lockdown but the number of recreational activities practiced in green areas has reduced by 70% (Berry et al., 2021). In a self-report survey of a population of confirmed walkers, it was stated that there was a rise of 30% in the number of tick bites during the first year of lockdown (15.5% in 2020 versus 11.6% in 2019) (Berry et al., 2021).

Even if there is not precise data made in Belgium about this, the same phenomenon also seemed to have appeared here. Several publications about it where published in the Belgian media (Van Ossel, RTBF, 2021; Bodeux, Le Soir, 2021).

The pandemic have brought a new wave of inexperienced walkers that are not especially aware of the risks that can be encountered. It seems that it also changed the behavior of walkers exposing them more to tick bites.

2.5 Objectives and hypothesis

This study has for objective to understand what are the activities and the habits that put the walker at high tick bite risk when going into a forest thanks to a survey. Knowing this, it would

be easier to orientate the prevention towards groups at risk. We also want to know if the knowledge about ticks can help prevent the bites and how the risks that we take inside woods can impact them.

This will also allow us to create a frequency map of the Bois de Lauzelle to see which part of the forest are the most popular and see, thanks to literature, if frequented roads are at risk. This will help to choose which route requires the most care.

3 Materials and method

3.1 Survey

A survey of 25 questions (Annex 1) was created for walkers that we would then meet in the Bois de Lauzelle. The survey is divided into four parts:

1. Personal informations : Questions about gender, age, occupation, etc. This allows to define the profile of the people surveyed and also their origin.

2. Habits in the forest: These questions asked what type of activities the walker usually do, the time of the walk or the visit frequency of the forest. The habits part was used to define the behaviours of the walkers to help to specify the profile that would need more prevention.

3. Knowledge about ticks: This section asked the walkers about their general knowledge in ticks and tick-borne diseases.

4. Route traveled: With a given map, they were asked to trace the path that they took to see which are the most frequented routes and the risks encountered.

Personal information was only requested The survey was anonymous and respect the personal data protection in compliance with the ethics committee. Each participant could request their participation to be withdrawn using a code linked to their returned survey. In our case, no participant requested a withdrawal. The code was also used to link the survey with a map of the woods that was given to allows the walkers to trace their path across the forest and later on analyse it.

Some questions allowed multiples options and some others asked for a quantitative answer. The table 1 shows which variable resulted from which question.

Question (*Multiple answers possible)	Variable obtained
What gender do you identify as?	*Men* *Women* *Other*
What's your age ?	*18-25* *26-35* *36-50* *51-65* *More than 65*
What is your current occupation ?	*Student* *Employee* *Independent* *Retired*
Do you have a pet ?*	*Dog* *Cat* *Not Pets*
How often do you go to the forest ?	*At least once a week* *At least once a month* *Between 2 and 10 times a year* *Once a year or never*
What do you do usually in a forest ?*	*Relaxing walk* *Jogging* *Hiking* *Biking* *Picking* *Horse riding* *Observation of nature* *Recreational activities* *Rest*
Do you ever go offroad in a forest ?	*Azimut*
Why did you come to the Bois de Lauzelle ?*	*Proximity* *Quality* *Recommendation* *Calm* *Random*
With who do you usually walk ?	*Alone* *Friends* *Kids* *Family* *Partner*
How long do you usually stay in a forest ?	*0-15 minutes* *15-30 minutes* *30-60 minutes* *60-120 minutes* *More than 120 minutes*
Do you plan to make any halt during your walk ? Why ?*	*Chatting* *Sit on benches* *Read panels* *Observation of nature* *No*

Question about knowledge (*Multiple answers possible)	Variable obtained
Have you been bitten by a tick this last year ?	*Tick bites*
Which of the following images is a tick ?	*Spider* *Bug* *Tick* *Dung Beetle* *Ant*
What size do you think a tick is ? *	*Less than 1mm* *1-2mm* *3-4mm* *5mm or more*
Where do you find your informations about ticks ? *	*Papers/Books* *Television* *Doctor/Specialist* *Internet* *Own experience* *Others's experience*
What time of year are we most likely to encounter ticks ? *	*Spring* *Summer* *Autumn* *Winter*
Do you know someone who have/had the Lyme disease ?	*Yes* *No*
Do you think tick-borne diseases are ?	*Frequent and grave* *Frequent and benign* *Rare and grave* *Rare and benign*
Do you use repellent while walking in a forest ?	*Always* *Often* *Rarely* *Never*
Do you use wear long clothes while walking in a forest ?	*Always* *Often* *Rarely* *Never*
Do you use put your pants in your socks while walking in a forest ?	*Always* *Often* *Rarely* *Never*
Do you use check your body after walking in a forest ?	*Always* *Often* *Rarely* *Never*
How do you remove a tick ?	*Tick tweezers* *Tweezers* *Bare hands* *Alcohol* *Other*

Table 1: Table of survey's question and the variables obtained with the answers

3.2 Study area

The survey took place in the Bois de Lauzelle, a forest of almost 200 hectares, which is located in the north of the city of Louvain-La-Neuve in the province of Brabant Wallon in Belgium. This forest belongs to the UCLouvain university and is integrated into the Natura2000 network (UCLouvain, 2022) thanks to its varied landscapes and the diversity of fauna and flora. This diversification is voluntary because it allows research within it, it is also for the same reason that certain infrastructures were developed (such as the pond for example) (Snoeck, 2001).

The Bois de Lauzelle has three different walking circuits (Figure 3) as well as various facilities, like informative panels, allowing walkers to learn more about the fauna and flora during their walk. In addition, a golf course is located right next to the forest, some passing through to reach it.

Figure 3: Map of the Bois de Lauzelle showing the three advised itineraries (Tourisme-olln.be)

A preliminary visit of the woods was made in February 2021 to help create the map which was to be given to the walkers. It also helps to establish the routes at risk by checking the vegetation.

3.3 The survey

The survey itself took place over five sessions on different days and different contexts. The first four sessions took place during the Easter holidays 2021, more precisely on Wednesday April 7th, Sunday April 11th, Tuesday April 13th and Saturday April 17th in the afternoon for all days. This period of the day was chosen to maximize the number of walkers met, the latter preferring the time of noon or later to go for a walk (Derks et al., 2020). A final session was organized on Saturday August 21st and was able to add enough data to achieve the goal of 150 surveys answered. These dates have been chosen to mix different profiles (weekdays, weekends, Wednesdays).

To cover the busiest entrances/exits, four volunteers were present at each session to interview walkers entering the Bois de Lauzelle. The data collection points are indicated in Figure 4. These points were chosen after a visit to the area beforehand and a subjective observation of the density of passers-by at the entrances/exits.

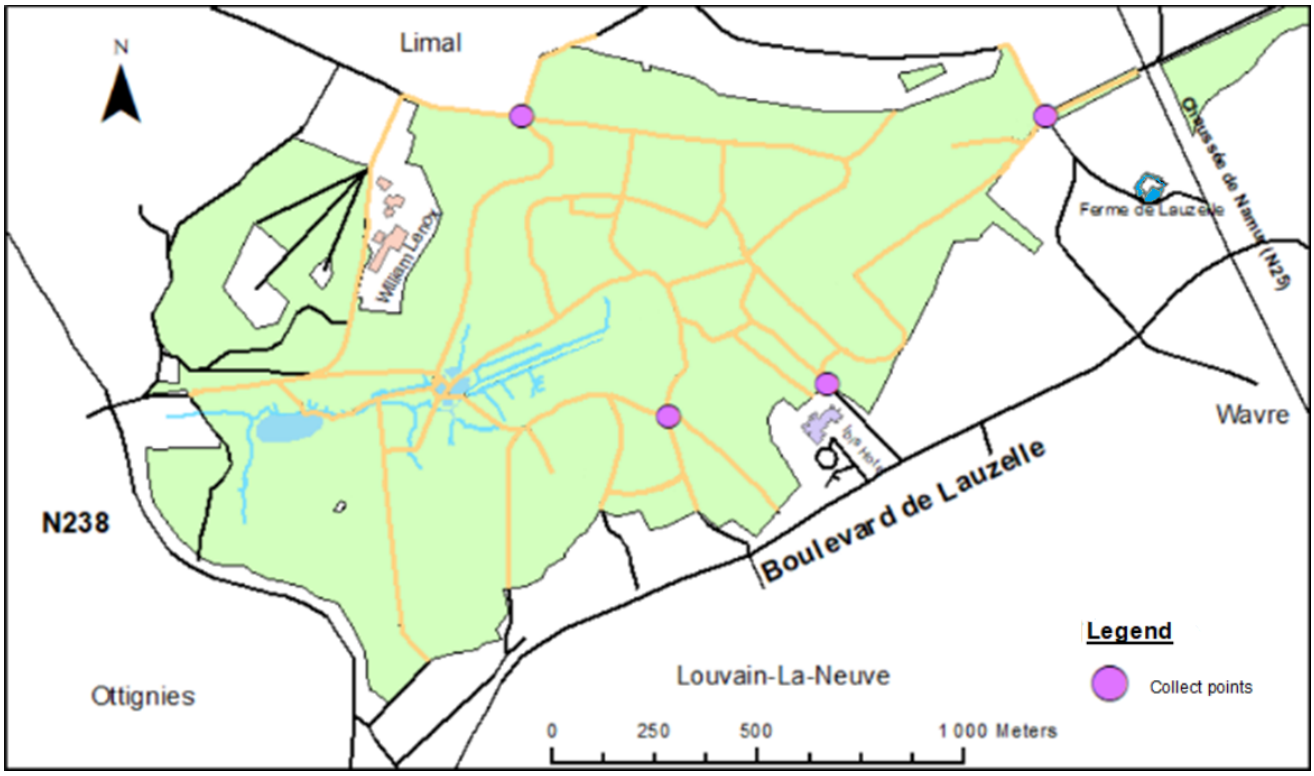

Figure 4: Map of the Bois de Lauzelle with the collect points

Each survey lasted about ten minutes and began with explanation of the subject as well as a statement of confidentiality. Only people entering the forest were surveyed to be able to give them the map to complete and for group walks, only one person was surveyed each time.

The survey was carried out with Survey123 (ESRI). The latter allows the use of an application on smartphones that is easy to use and allows the recorded responses to be stored until an internet connection is obtained.

To know the route walked by the people surveyed, a map (figure 5) and a pencil were given after the survey so that they could draw the route they followed. The map was made after the preliminary visit to identify structures for the walkers to be able to locate themselves more easily. To not overcrowd the map, only benches and panels were indicated as well as special structures like the golf, parkings, restaurant, hotel and the William Lenox Center. A paper ensuring anonymity and a preventive flyer were also given after the survey (Annex 2 and 3)

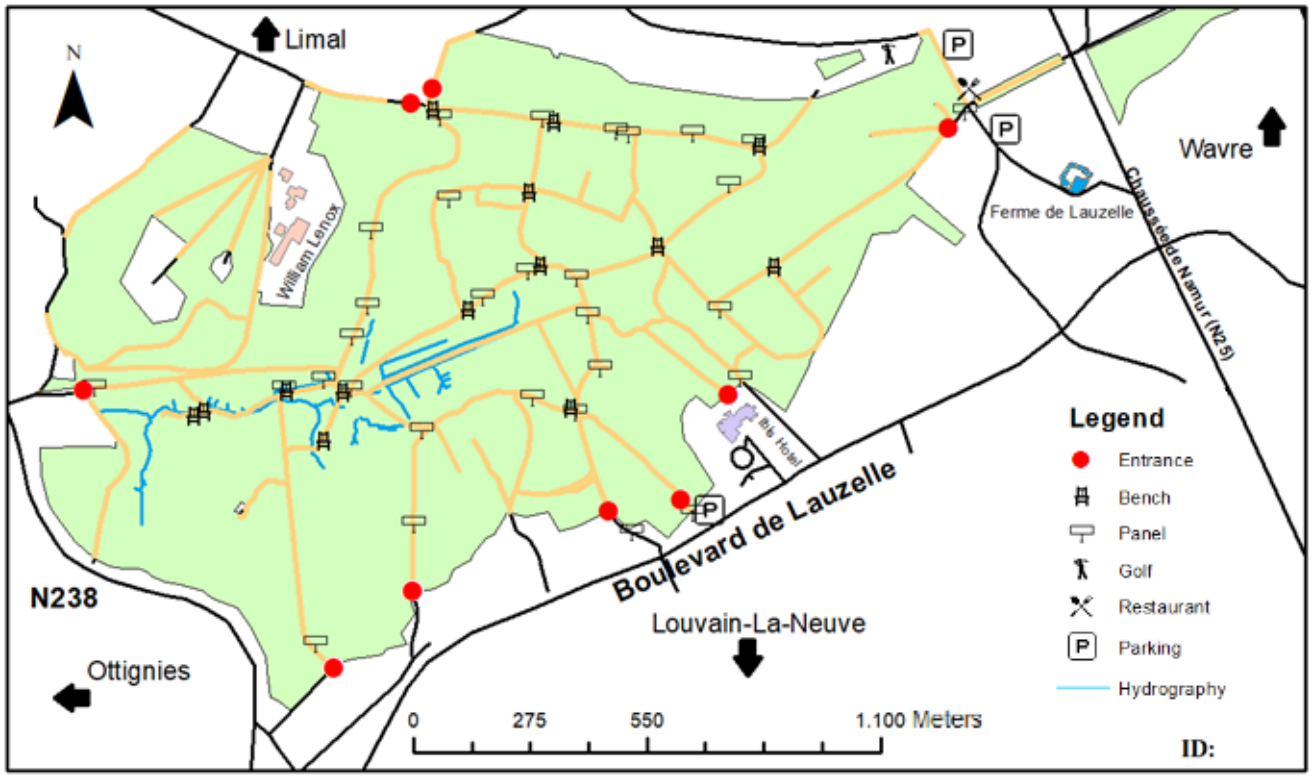

Figure 5: Map of the Bois de Lauzelle given during the survey

Other methods were considered to record the path such as GPS tracking or even asking for the route at the end of the walk. The first option was ruled out due to the lack of material available as well as restrictions on the target audience. The second option was more practical but required the walker to remember the path taken without a map, which could lead to errors.

The option chosen was therefore to give the map at the start and to ask to return the completed map in one of the boxes located at the exits of the forest indicated on the map. They could thus deposit the map even when the interviewers had left. The boxes were collected later in the evening.

3.4 Statistical analysis

3.4.1 Database work

The objective is to find the profile requiring more prevention in terms of ticks and associated diseases to prevent risks and bites. To do so, adjustments had to be made to the raw database before it could be used. The code can be found in the annex (Annex 4)

The survey having some questions with multiple choices allowed, the final database was made with every possible answer as a column and with the lines indicating the presence/absence of this answer for one respondent. This option also makes it possible to statistically take into account responses in the "Other" category who came back the most.

3.4.2 Dependant variables

The first dependant variable (*Tick Bites*) is the number of times that the walker has been bitten by a tick during the year before his answer. The *Tick Bites* variable was categorized in two

groups, yes or no, for whether they were bitten or not.

Another dependant variable is *Knowledge*. This one is resultant of the part of the survey that concerns the ticks knowledge. We evaluated the knowledge about the tick itself, the seriousness of the tick-borne diseases and about prevention methods. Each answer can be noted, and everything can be then reduced to a note out of 10. The variable was then categorized in four groups: weak (<4), average (>=4, <5), good (>=5, <=6), very good (>6)

The value "Risk" based on the maps represents the number of times that the walker has taken a risky road during his walk. A road is defined like the path between two intersections and a road was counted once if the walker passed on it several times. This value *Risk* is going to be one of our dependant variables. The *Risk* variable was categorized in three groups: weak (0-1), medium (2-3) and high (>4).

The riskiness a road was determined during the preliminary visit of the forest. The conditions to be risky were that the road needed vegetation to overtake on the path and the width was too narrow for two people to pass each other without encountering these overtaking. Furthermore, seen that we don't know exactly the frequency of the road's maintenance, the riskiness of a road can be subject to change.

The paths followed by the walkers were recorded manually and joined with the survey's answers thanks to the ID that was distributed to every answerer.

The percentage of risky road taken is not considered because we want to know the duration of the risk taking. A person who took only three paths but with two of them considered risky will be exposed the same way as someone who also only took two risky roads but with a total of six roads in the end while the percentage would be 66% and 33% respectively.

The groups were made following the Jenks method in statistics which consist on looking to reduce the variance within classes and maximize the variance between classes (Field, 2014). The categorization will also help for discussion and interpretation.

3.4.3 Preliminary analysis

Contingency tables were made to calculate odd ratios which will help to check in which category of the dependent variable the independent variable is the most represented. Odd Ratios allows us to measure the effect size for the categorical data (Field, 2014). For example, we have a contingency table (Table 2) , the possession of dogs with the fact of being bitten.

	No dogs	Dogs	OR
No bites	37	20	1.081
Bites	64	32	0.925

Table 2: Example of contingency table

To calculate the odds ratio, we have to calculate the odds which means the owning of a dog with no bites divided by the owning of a dog with bites. The same must be done with the non possession of a dog.

$$Odds_{Dogs} = \frac{Nobites}{Bites} = \frac{20}{32} = 0.625 \quad (1)$$

$$Odds_{Nodogs} = \frac{Nobites}{Bites} = \frac{37}{64} = 0.578 \tag{2}$$

Now the ratio for the *Nobites* can be calculated by dividing the $Odds_{Dogs}$ by $Odds_{Nodogs}$

$$OddsRatio = \frac{Odds_{Dogs}}{Odds_{Nodogs}} = \frac{0.625}{0.578} = 1.081 \tag{3}$$

This shows that people with dogs have 1.081 higher chances of not being bitten by a tick compared to not having a dog.

3.4.4 Pearson's Chi-squared test

The objective is now to sort all the remaining variables and see which ones is worthy to be included for the next step. The Pearson's Chi-squared test was used and not the Fisher test due to the high quantity of data. The null hypothesis for the Chi-squared test tells that the two variables considered are independent. In other words, knowing one variable cannot help to predict the second one. The p-value is here fixed at 0.1 to allow more flexibility with the choice of the variables we keep after.

3.4.5 Logistic regression

The goal here is to estimate the probability that a given observation presents a certain value of the categorized variable. After verification of which variable has a pertinent p-value with the Pearson's Chi-squared test, threshold defined at 0.1, we can run individuals logistic regressions and check which one of them can predict the given dependent variable. The *Tick bites* was in a binomial logistic regression while the others two were in a multinomial regression.

The odd ratios of the coefficients of the regression were also computed to see the level of power for each predictive variable. The reference category for *Risk* and *Knowledge* was *Weak*, and for *Tick bites* it was *No*. In addition, a Pearson's residual test was made to verify the relevance of the models.

After seeing which variable is significant or not, we can run one multiple logistical regression per dependent variable to see how the variables will act if they are considered together. To avoid interaction between the variable, another Chi-squared test was made between the variables to see if some depend on each other.

4 Results

4.1 Path taken by the walkers

At the end of the surveying, 13 of the 167 distributed maps were never recovered or were illegible. Figure 8 indicates the frequency of passage of the trails of the Bois de Lauzelle the based on the 154 maps returned and the riskiness of these trails. The most frequented routes are the ones that follow the three advised circuits shown at most of the entrances of the woods, the values varying between 17 to 27% for the most frequented. We can also notice that most of the most frequented roads lead to an infrastructure whether it is the golf course, the hotel or the parking. The preliminary visit of the woods told us that nearly 32% of the roads in the Bois de Lauzelle are considered risky according to criteria seen above.

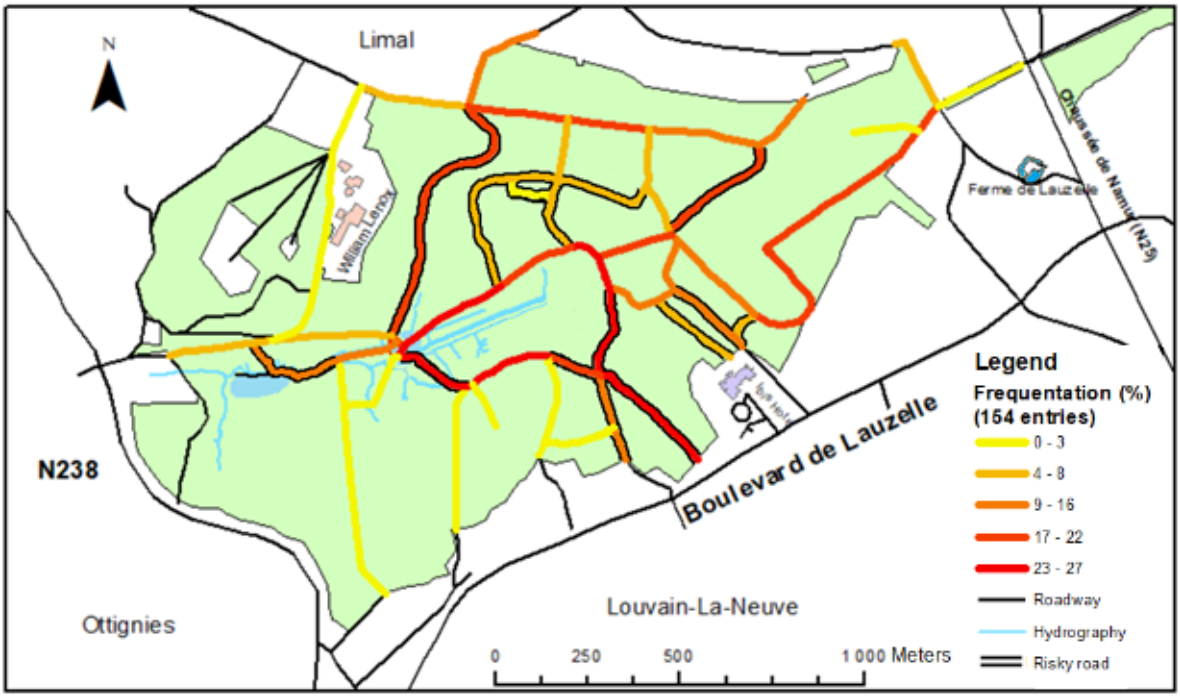

Figure 6: Frequentation map of the Bois de Lauzelle including the riskiness of the trails

4.2 Survey analysis

4.2.1 Univariate analysis

The adjustments done to the database allowed us to sort the variables. Some values considered irrelevant because of their small number have been merged to keep as much data as possible. The merge was made with coherence and was made variables of the same category. The merged values are:

- *Kids*, which indicates if the walk was done with childrens, and *Family*, which indicates going on a walk with family in general, were merged into *Family* to show persons who go into the forest with family as a whole.
- *0-15* and *15-30*, which say the duration of the walk (less than 15 minutes and between 15 and 30), were merged in *0-30*, a variable including a walktime from 0 to 30 minutes.
- *Between 2 and 10 times a year* and *Once a year or never* were merged in *Less than once a month.*

4.2.2 Profiles

The first look at the survey's answers allows to explore the distribution of many variables according to certain profiles (gender, age, occupation, origin and owning of a pet) (Annex 5). 46.4% of men have answered the survey, 28,1% of the respondents are under 25 while 13.1% are above 65 years old (Figure 7) which can be linked to the fact that older people walk globally longer than younger ones (OR: 2.44).

When comparing with the occupation, we had 24,2% of students and 19,6% of retired people. Most of the respondents were employees with 40,5% (Figure 8). In terms of pets, 34% of the walkers surveyed have a dog against 20,3 having a cat (Figure 9).

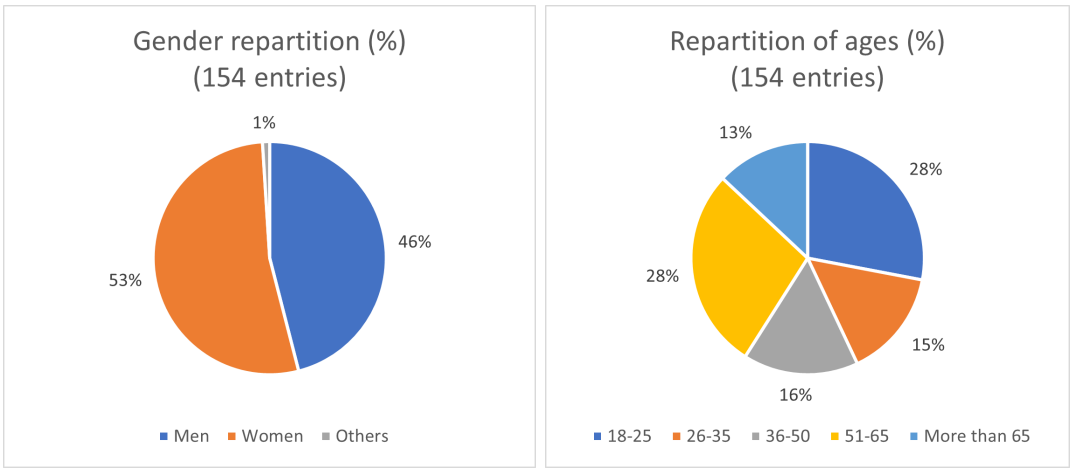

Figure 7: Graphs of gender and ages distribution

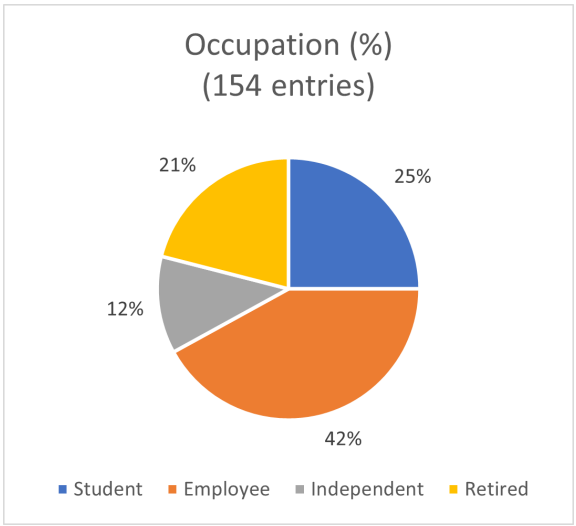

Figure 8: Graphs of occupation distribution

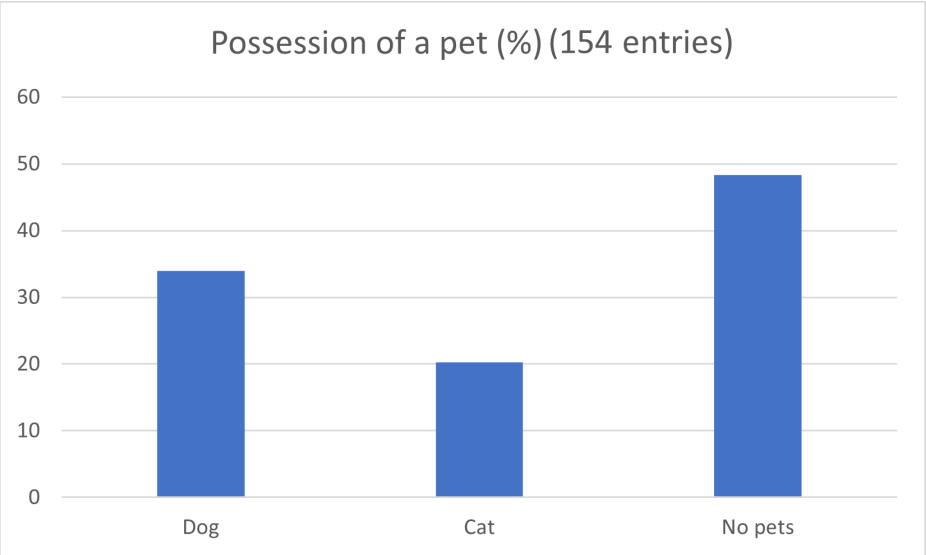

Figure 9: Histogram of pets distribution

4.2.3 Habits

There are different sorts of activities possible in the Bois de Lauzelle, and the reason for visiting the woods can be varied (Figure 10). For example, 86.9% say they come to the woods to relax from work or studies. Sports is also possible with 22.2% of respondents who sometimes go running, 26.8% who practice hiking or 11.8% often ride a bike. Furthermore, 44.4% of people say that they sometimes go off-road during their walk.

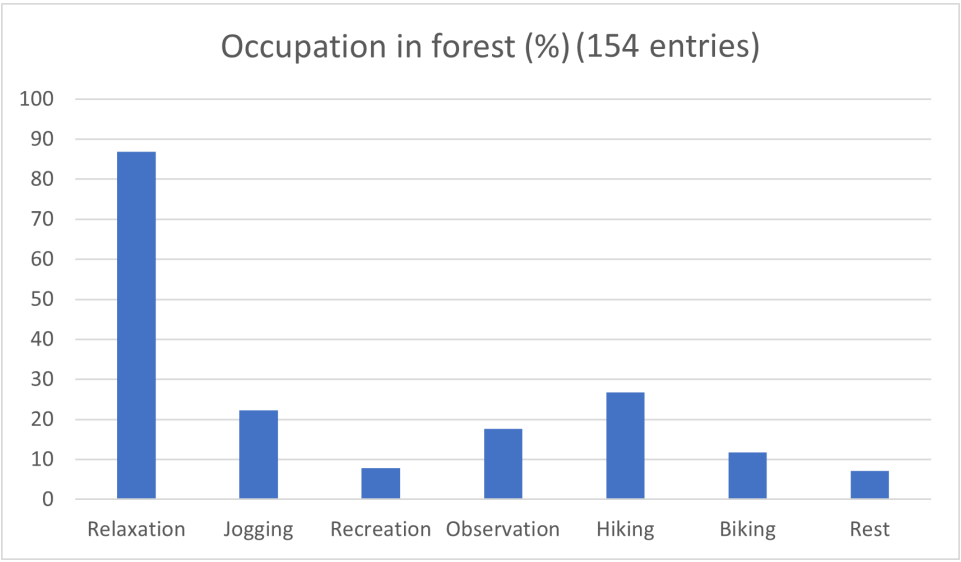

Figure 10: Histogram of activity distribution

Most of the respondent are used to have a frequency walk of at least once a week (52.3%) while 15% do it less than once a month (Figure 11).

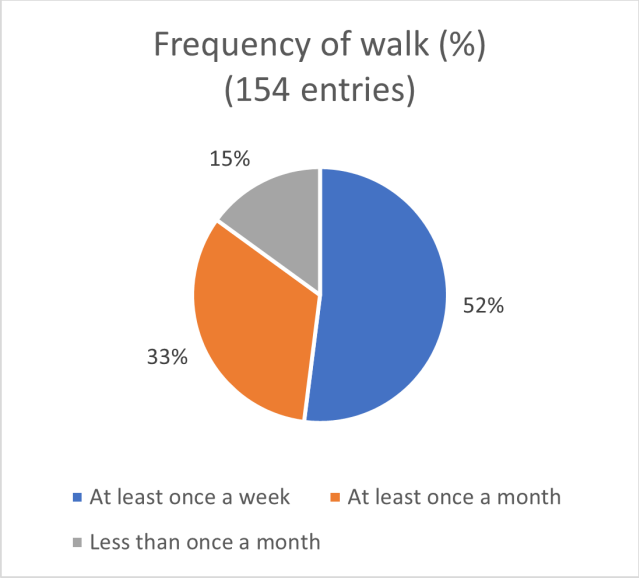

Figure 11: Graph of frequency walk distribution

The reason to go to the Bois de Lauzelle instead of some other places can vary (Figure 12). One of the most popular reason is the proximity, quoted by 68% of the respondent. 26.1% have chosen the woods because of their quality, while some came by recommendation or by chance (15%, 13.7%).

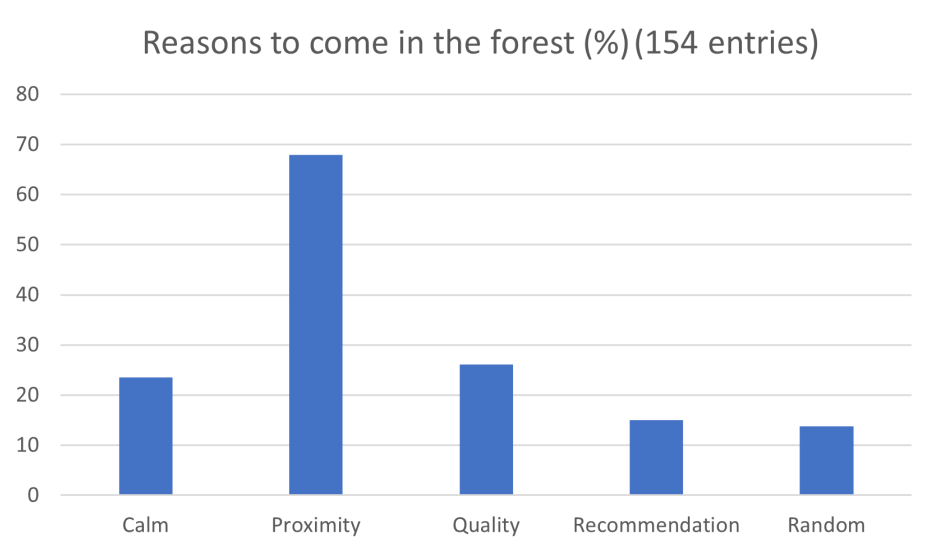

Figure 12: Sorting of the reasons of the walk distribution

Some use the opportunity of a walk to spend time with loved ones, 21.5% walks frequently with their partner, some go with friends or family (20.3%, 20.9%) while others prefer sometimes to go on their own (37.2%) (Figure 13).

The duration of the walk is also a variable that fluctuates. A small walk of less than 30 minutes is preferred by 11.8%, one between 30 and 60 minutes is favored by 27.4%, one between one and two hours by 47% and one of more than two hours by 12.4% (Figure 13).

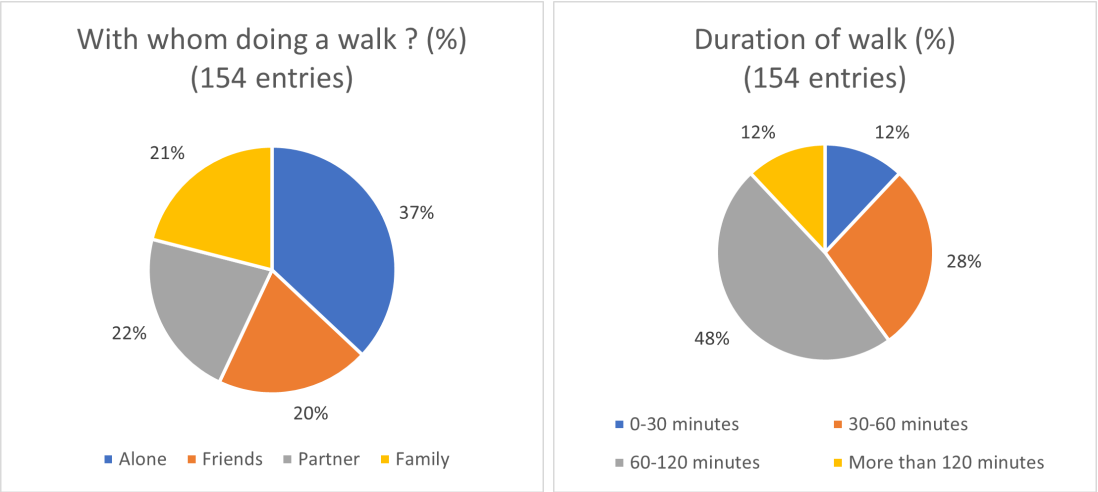

Figure 13: Graphs of who are the group members in a forest and the mean duration of the walk

43.1% said they were not planning to mark stops during their walk especially. The reasons to stop are the following: some prefer whether to sit on a bench, to read the different panels or to chat with someone else (33.3%, 9.8%, 11.1%). Finally, 30.7% considered stopping to admire the surrounding nature (Figure 14).

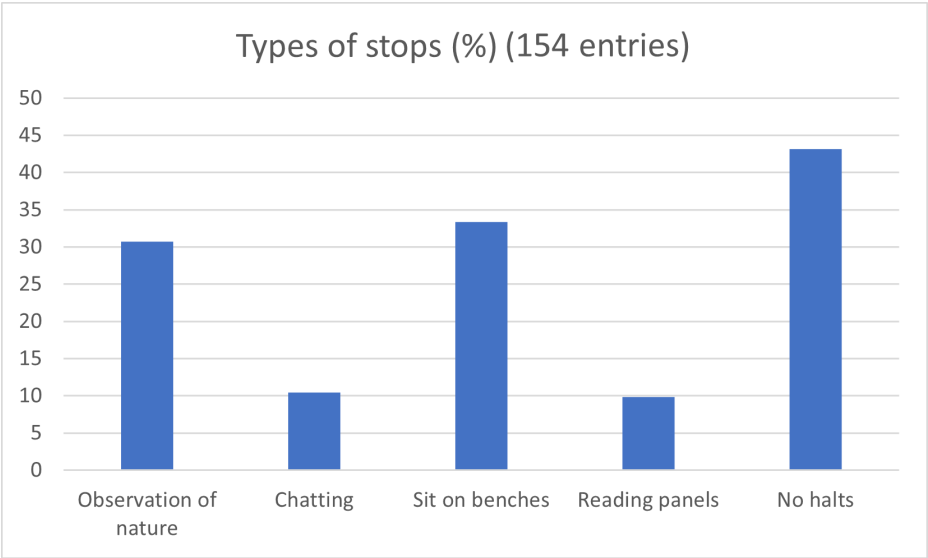

Figure 14: Sorting of the different kinds of stops

The complete habits table can be found in the annex (Annex 6)

4.2.4 Knowledge and prevention

In order to achieve to prevent people effectively, we must first know what the population already knows about the ticks (Annex 7). At first, after seeing images of five different insects, spider, ant and beetle among them (Annex 8), 89.6% spotted the tick. (Figure 15)

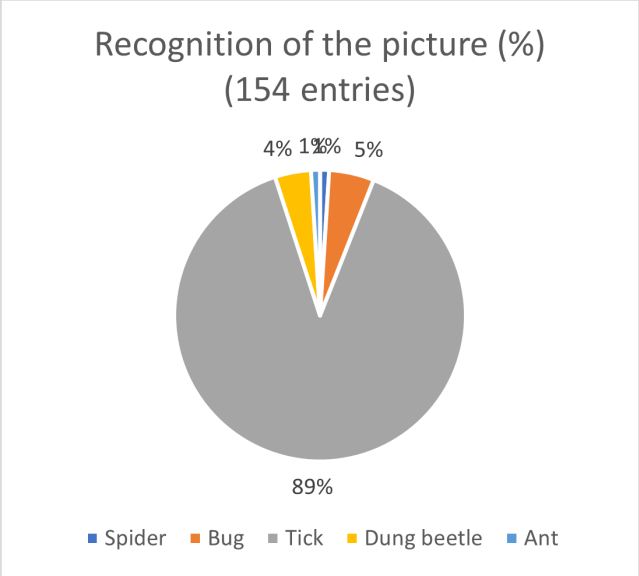

Figure 15: Graph of the recognition of the tick picture

When asking where their knowledge of ticks comes from, 35,7% answered the internet, 24% their doctor, 14.9% said by reading in magazines or books and 11% based their knowledge on television. Some also answered that they learned from experience from others or themselves (44.2%, 37.66%) (Figure 16).

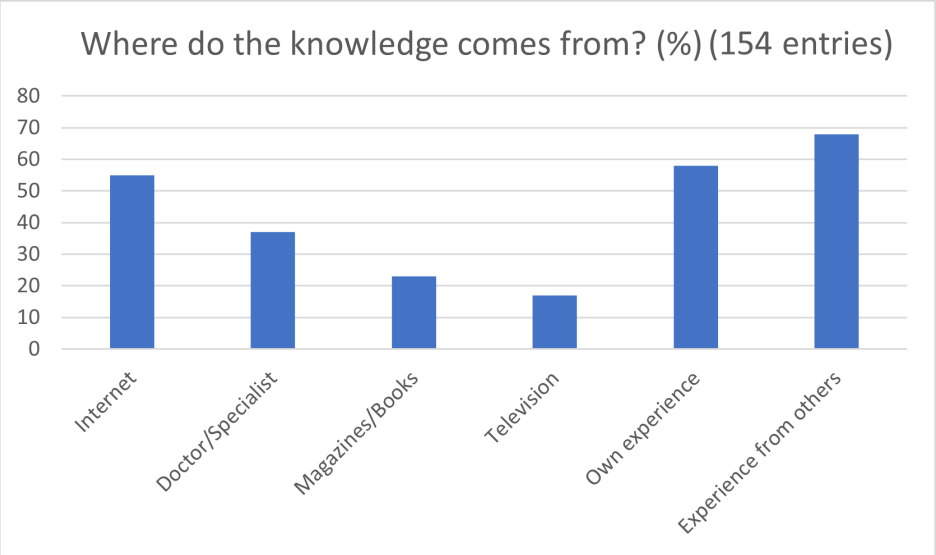

Figure 16: Sorting of the different origins of tick knowledge

About tick-borne diseases, 51.3% think they are rares and serious, 35% think that they are frequent and serious, while some think that they are whether benign and rare or benign and frequent (5.2%, 8.4%). Right after they were asked if they knew someone who were affected by the Lyme borreliosis and 61% answered positively (Figure 17).

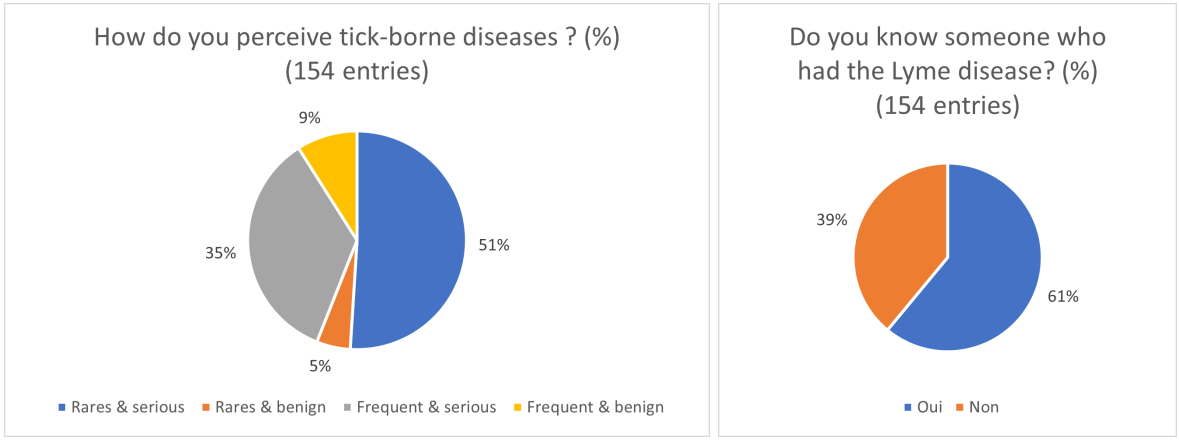

Figure 17: Graphs of the knowledge of the seriousness of TBD and knowing someone who had LB

In terms of protection, 75.3% indicate never using repulsives while 2.6% always use it, 40.9% never wear long sleeves shirts or pants, 74% never put their pants in their socks and 31.2% never check their bodies at the end of the walk. On the other side, 26% always check their body, 4% always wear the pants in the socks, 19.5% always wear long clothes (Figure 18).

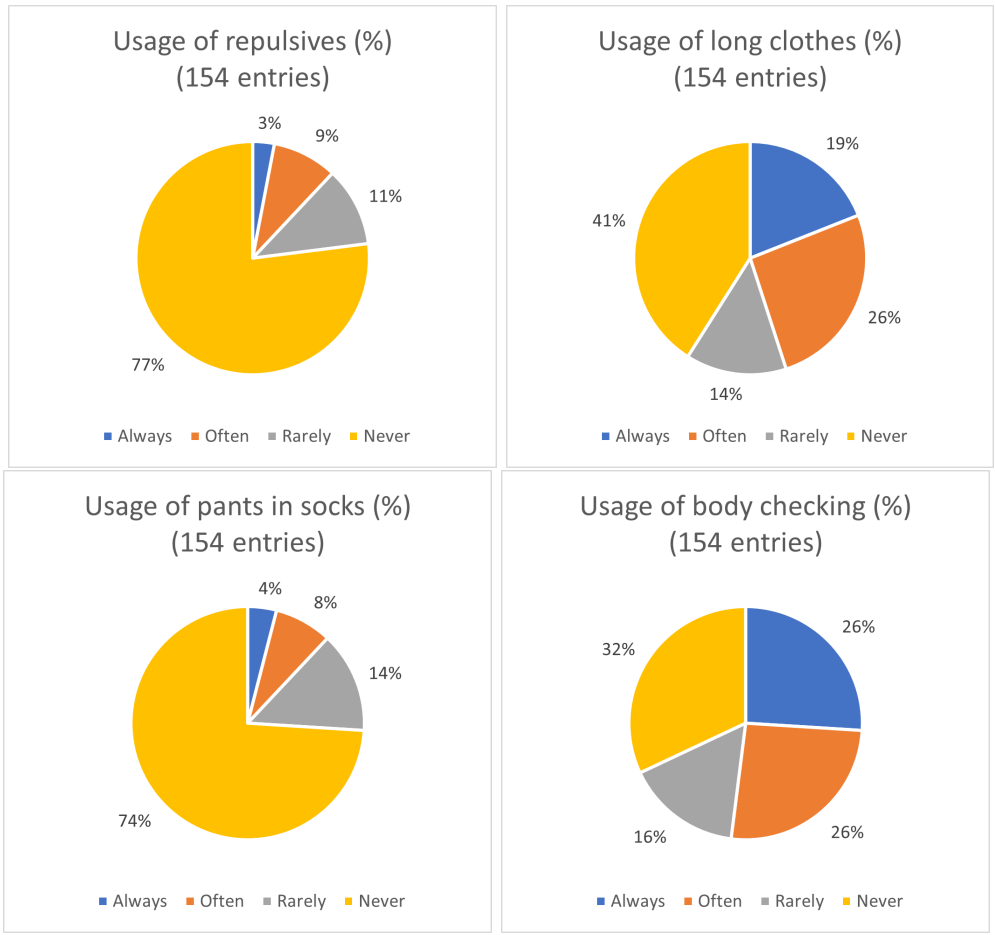

Figure 18: Graphs of the application of several ways of prevention

Respondents were asked about how to remove a tick when one is spotted, and 63.6% answered that they use a tick tweezers, 21.4% use simple tweezers while others use either hand, alcohol, or other non-advised method (8.4%, 14.3%, 8.4%) (Figure 19).

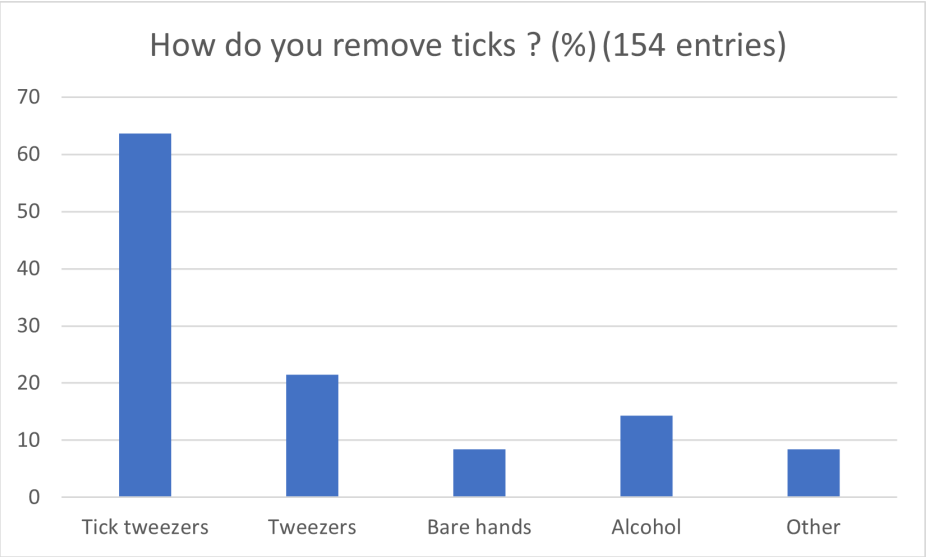

Figure 19: Histogram of methods used to remove ticks

4.2.5 Origin of the walkers

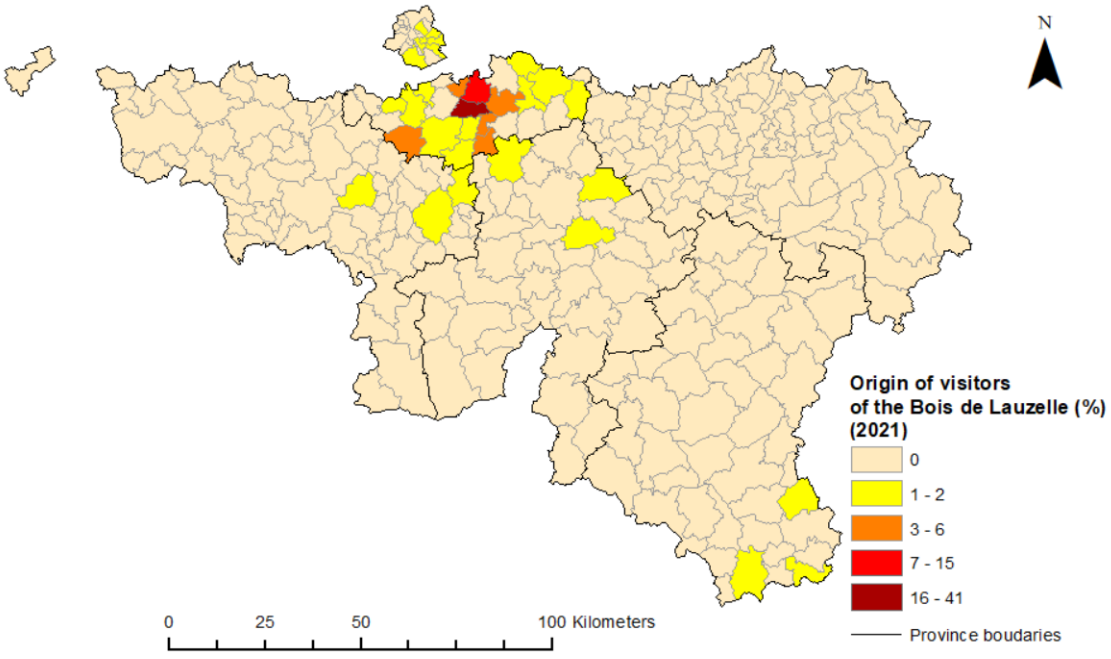

Figure 20: Origin map of the walkers surveyed

As expected, figure 20 show that a vast majority of the walkers come from Louvain-La-Neuve itself or the nearby municipalities (Wavre, Ottignies). A smaller part of the walkers come from towns nearby like Nivelles, Rixensart, Mont-St-Guibert or Chastres. The last small part come mostly from other cities in the Walloon Brabant, some other from municipalities in Brussels and others from the Ardennes in the south.

4.2.6 Dependant Variables

As established previously, our three dependant variables are having been bitten by a tick the year prior to the survey, the level of knowledge and the risk taken while walking.

First, 62.7% of the walkers answered that they suffered at least one tick bite in the last year (Figure 21) and the distribution by gender is nearly perfectly split in half (46.4% for the men and 53.6% for the women). Among the bitten people, 27.1% are between 18 and 25 years old while 43.75% are over 50 years old.

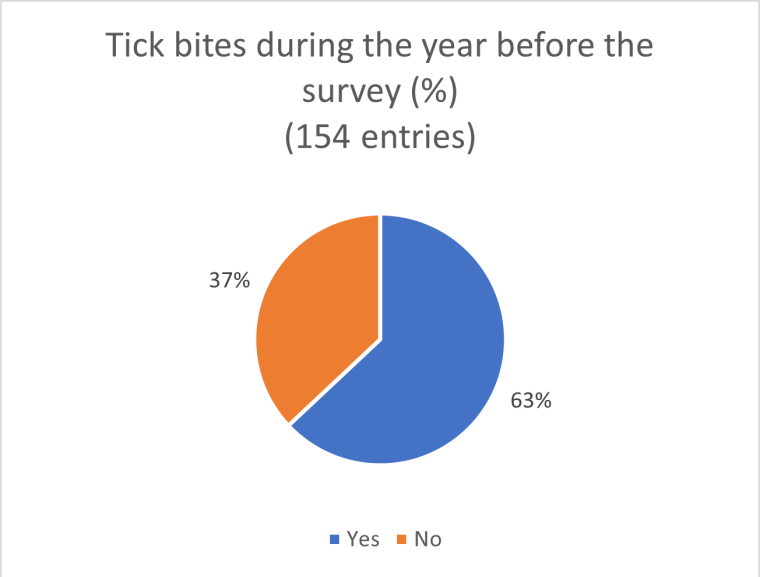

Figure 21: Graph of distribution of tick bites during the year before the survey

The level of knowledge was spread in four categories. The first one, weak, correspond to 39.2% of the population surveyed. The average category was represented by 26.8% and the good one by 17.5%. Finally, 11.11% are considered having a very good knowledge about ticks and the diseases (Figure 8).

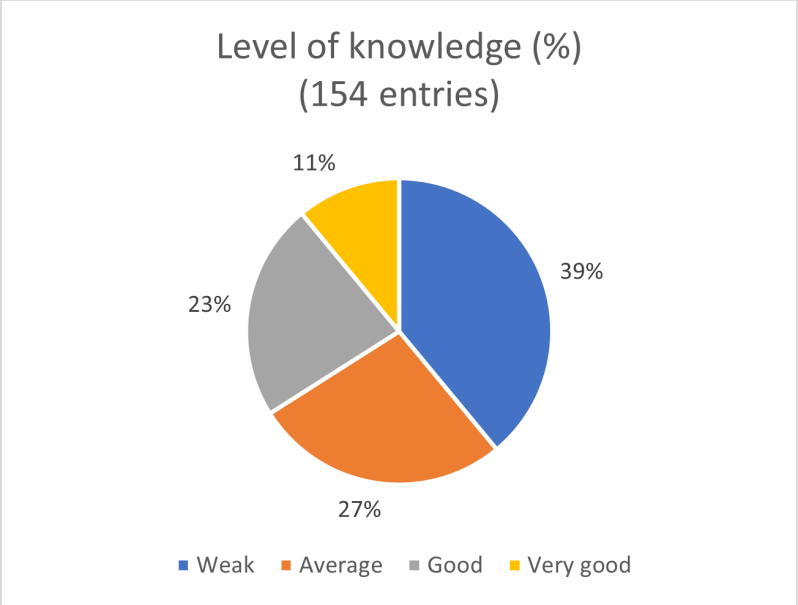

Figure 22: Graphs of the level of knowledge

The number of path at risk taken by the walkers are distributed in three categories : Weak, medium and strong. We've seen earlier that 31.4% of the roads were classed at risk during the preliminary visit and now we see that 24.8% have taken a high number of risky road making their journey at strong risk globally. 39.9% have taken less risky roads but still expose themselves at

a medium risk and 35.3% walked on a minimum risky paths and so expose themselves the least (Figure 23).

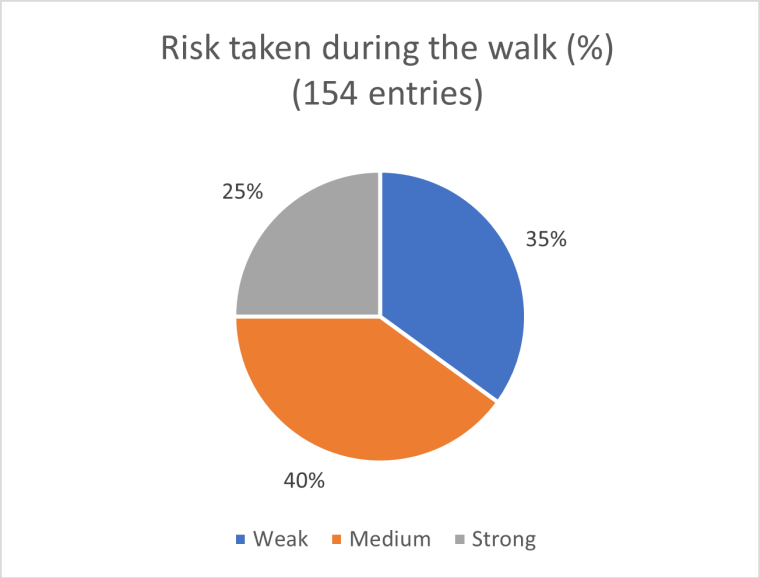

Figure 23: Risk taken during the walk

4.3 Pearson's Chi-squared test

To be more flexible, the p-value's maximum value was here fixed at 0.1.

4.3.1 Tick bites

The variables that could explain *Piqure* are (Table 3): Possession of a cat (0.003), going on a walk less than once a month (0.066), hiking (0.029), making stops to chat (0.015) and the level of knowledge (0.026).

Tick bites		
Variable	P_val Chi^2	Chi^2
Gender		
Men	0.513	0.43
Women	0.436	0.61
Age		
18-25	0.858	0.03
26-35	0.534	0.39
36-50	1	0
51-65	0.349	0.88
Over65	0.981	0.0006
Occupation		
Student	0.779	0.08
Employee	0.586	0.29
Independent	0.352	0.87
Retired	0.776	0.08
Possession of a pet		
Dog	0.964	0.002
Cat	0.003 *	1.73
No pets	0.188	1.73
Frequency		
Once a week	0.269	1.22
Once a month	0.964	0.002
Less than once a month	0.066 *	3.38
Activity		
Relaxation	0.637	0.22
Jogging	1	0
Recreation	0.22	1.5
Observation	0.806	0.06
Hiking	0.029 *	4.75
Biking	0.915	0.011
Rest	0.699	0.15
Azimut	0.197	1.66
Reason		
Calm	0.719	0.13
Proximity	1	0
Quality	0.195	1.68
Recommendation	0.366	0.82
Random	0.193	1.69
With whom ?		
Alone	0.927	0.008
Friend	0.205	1.61
Partner	0.369	0.8
Family	1	0
Duration of the walk		
0-30 minutes	1	0
30-60 minutes	0.285	1.14
60-120 minutes	0.657	0.19
More than 120 minutes	0.423	0.64
Stops		
Observation of nature	0.146	2.11
Chatting	0.015 *	5.94
Benches	0.859	0.03
Read panels	0.96	0.002
No halts	0.187	1.74
Risk	0.286	2.5
Level of knowledge	0.026 *	9.29

Table 3: Results of Pearson's Chi-squared test for the *Tick Bites* variable (Significance = *)

4.3.2 Level of knowledge

(Table 4) show that the level of knowledge is dependent with the following variables: owning a dog (0.024), non possession of a pet (0.066), going on a walk at least once a week (0.026) and less than once a month (0.094), doing recreational activities (0.059), observing nature (0.02), going by recommendation (0.066) and for the calm (0.052), marking halts to chat with someone (0.044) and finally being bitten the year before (0.026).

Knowledge		
Variable	P_val Chi^2	Chi^2
Gender		
Men	0.424	2.79
Women	0.354	3.26
Age		
18-25	0.841	0.84
26-35	0.189	4.77
36-50	0.689	1.47
51-65	0.586	1.93
Over65	0.343	3.34
Occupation		
Student	0.864	0.74
Employee	0.999	0.029
Independent	0.452	2.63
Retired	0.462	2.57
Possession of a pet		
Dog	0.024 *	9.42
Cat	0.282	3.82
No pets	0.066 *	7.18
Frequency		
Once a week	0.026 *	9.24
Once a month	0.374	3.12
Less than once a month	0.094 *	6.38
Activity		
Relaxation	0.767	1.14
Jogging	0.873	0.7
Recreation	0.059 *	7.4
Observation	0.02 *	9.8
Hiking	0.825	0.9
Biking	0.355	3.25
Rest	0.805	0.99
Azimut	0.248	4.12
Reason		
Calm	0.052 *	7.7
Proximity	0.521	2.25
Quality	0.706	1.39
Recommendation	0.066 *	7.18
Random	0.8	1.003
With whom ?		
Alone	0.634	1.71
Friend	0.109	6.06
Partner	0.613	1.81
Family	0.611	1.82
Duration of the walk		
0-30 minutes	0.115	5.93
30-60 minutes	0.851	0.79
60-120 minutes	0.491	2.41
More than 120 minutes	0.772	1.12
Stops		
Observation of nature	0.257	4.05
Chatting	0.044 *	8.12
Benches	0.536	2.18
Read panels	0.152	5.28
No halts	0.197	4.68
Risk	0.498	5.36
Bites	0.026 *	9.29

Table 4: Results of Pearson's Chi-squared test for the *Knowledge* variable (Significance = *)

4.3.3 Risk taking

Table 5 shows the candidate explanatory variables significantly associated to risk taking: going on a walk at least once a month (0.039), coming to the forest by recommendation (0.092) and taking whether a 30 to 60 minutes walk (0.011) or a one to two hours walk (0.017).

Risk		
Variable	P_val Chi^2	Chi^2
Gender		
Men	0.937	0.13
Women	0.878	0.26
Age		
18-25	0.939	0.12
26-35	0.928	0.15
36-50	0.403	1.82
51-65	0.697	0.72
Over65	0.301	2.4
Occupation		
Student	0.795	0.46
Employee	0.829	0.37
Independent	0.684	0.76
Retired	0.662	0.82
Possession of a pet		
Dog	0.992	0.16
Cat	0.452	1.59
No pets	0.824	0.39
Frequency		
Once a week	0.196	3.26
Once a month	0.039 *	6.5
Less than once a month	0.672	0.79
Activity		
Relaxation	0.526	1.28
Jogging	0.478	1.48
Recreation	0.695	0.73
Observation	0.258	2.71
Hiking	0.639	0.89
Biking	0.493	1.42
Rest	0.238	2.87
Azimut	0.678	0.78
Calm	0.301	2.4
Proximity	0.187	3.36
Quality	0.277	2.56
Recommendation	0.092 *	4.77
Random	0.21	3.12
With whom ?		
Alone	0.642	0.89
Friend	0.986	0.03
Partner	0.332	2.2
Family	0.858	0.3
Duration of the walk		
0-30 minutes	0.595	1.04
30-60 minutes	0.011 *	9.02
60-120 minutes	0.017 *	8.15
More than 120 minutes	0.424	1.72
Stops		
Observation of nature	0.402	1.82
Chatting	0.721	0.65
Benches	0.958	0.08
Read panels	0.229	2.95
No halts	0.556	1.17
Level of knowledge	0.498	5.37
Bites	0.286	2.5

Table 5: Results of Pearson's Chi-squared test for the *Risk* variable (Significance = *)

4.4 Logistic regression model

4.4.1 Tick bites (Univariate)

Based on the results of the Pearson's Chi-squared test, here is what can be observed about the predictive power of the remaining variables (Table 6). We observe that owning a cat is a significant predictor of the probability of to tick bites (p-val = 0.004) as well as making a stop to discuss during a walk (p-val = 0.025). Going on a hike promotes also being bitten (p-val = 0.02) whereas going on a walk less than once a month is inversely linked to the bites (p-val = 0.042). Finally, a high level of knowledge is positively related to being bitten (p-val = 0.07; p-val = 0.007).

Variable / Tick Bites	OR_Yes (Ref Class: *No*)	P-val$_{Yes}$
Possession of a cat	5.18	0.004
Goes on a walk less than once a month	0.393	0.042
Hiking activity	2.67	0.02
Halts for discuss	10.37	0.025
Knowledge		
Average	1.32	0.49
Good	3.74	0.007
Very Good	3.04	0.07

Table 6: Results of the univariate logistic regression for the *Tick Bites* dependent variable

4.4.2 Tick bites (Multiple)

Table 7 shows nearly the same conclusions as the univariate regression but with less power, the OR being a little lower. The p-value of the frequency of the walk (less than once a month) has however quite rises (p-val = 0.18) and its OR increases also a bit.

Variable / Tick Bites	OR_Yes (Ref Class: *No*)	P-val$_{Yes}$
Possession of a cat	4.31	0.014
Goes on a walk less than once a month	0.48	0.18
Hiking activity	2.34	0.067
Halts for discuss	6.91	0.075
Knowledge		
Average	1.17	0.73
Good	2.71	0.066
Very Good	2.47	0.168

Table 7: Results of the multiple logistic regression for the *Tick Bites* dependent variable

4.4.3 Level of knowledge (Univariate)

The results shown by the table 8 tell us that owning a dog seems to predict a good knowledge (p-val = 0.06), but predicts more a very good knowledge comparing to not having a dog (p-val = 0.004). This is confirmed when we see that the non-possession of a pet seems to predict the inverse of a decent knowledge (p-val = 0.05). Furthermore, having a regular frequency of walk seems to allows you to have at least an average knowledge (p-val = 0.004). Looking for calm

and practicing activities close to nature permit to have very good knowledge ($p - val_{Recre} = 0.03$; $p - val_{Obs} = 0.005$). A good knowledge seems also to appear by people who stops for a chat (p-val = 0.016) and for people who already suffered a tick bite the previous year (p-val = 0.008; p-val = 0.08). Finally, coming on the forest on recommendation is somewhat negatively significant to a good knowledge (p-val = 0.07).

Variable / Knowledge	OR_Average (RC: *Weak*)	P-val$_{Average}$	OR_Good (RC: *Weak*)	P-val$_{Good}$	OR_Very Good (RC: *Weak*)	P-val$_{Verygood}$
Possession of a dog	2.08	0.1	2.4	0.06	5.16	0.004
No pets owned	0.44	0.05	0.41	0.04	0.34	0.06
Goes on a walk once a week	3.46	0.004	1.91	0.13	2.29	0.14
Recreational activities	4.66	0.19	9.83	0.04	12.64	0.03
Observation activity	1.54	0.48	2.67	0.1	6.3	0.005
Visit for calm	1.03	0.96	2.61	0.05	3.5	0.04
Visit by recommendation	0.43	0.17	0.24	0.07	1.67	0.41
Halts for discuss	1.5	0.63	5.63	0.016	2.53	0.33
Tick bites	1.32	0.49	3.74	0.008	3.04	0.08

Table 8: Results of the univariate logistic regression for the *Knowledge* dependent variable

4.4.4 Level of knowledge (Multiple)

Before running the multiple regression, the Chi-squared test made between the variables to check their link tells us that No Pets should be removed. Table 9 supports that the possession of a dog as well as "close to nature" activities (recreation, observation) is positively linked to a high knowledge about ticks ($p - val_{Recre} = 0.07$; $p - val_{Obs} = 0.01$). However, the p-value for the weekly frequency has raised and doesn't seems significant anymore to a good knowledge (p-val = 0.22) but only to an average one (p-val = 0.002). The visit by recommendation still is inversely linked to a good level of knowledge (p-val = 0.06). The results for the tick bites and the halts for chat are quite the same, a positive link to a good knowledge for both of them ($p - val_{Bites} = 0.052$; $p - val_{halts} = 0.038$) and another positive link to a very good knowledge for the experience of tick bites (p-val = 0.069).

Variable / Knowledge	OR_Average (RC: *Weak*)	P-val$_{Average}$	OR_Good (RC: *Weak*)	P-val$_{Good}$	OR_Very Good (RC: *Weak*)	P-val$_{Verygood}$
Possession of a dog	2.33	0.076	2.99	0.032	6.07	0.004
Goes on a walk once a week	3.8	0.002	1.8	0.22	1.92	0.31
Recreational activities	4.91	0.19	5.98	0.14	11.24	0.07
Observation activity	1.43	0.58	2.17	0.26	6.05	0.01
Visit for calm	0.86	0.8	1.82	0.29	3.1	0.1
Visit by recommendation	0.41	0.18	0.18	0.06	3.25	0.14
Halts for discuss	1.95	0.46	5.57	0.038	0.71	0.78
Tick bites	1.11	0.8	2.85	0.052	3.89	0.069

Table 9: Results of the multiple logistic regression for the *Knowledge* dependent variable

4.4.5 Risk taking (Univariate)

Table 10 shows that coming on the forest on recommendation (p-val = 0.03) as well as having a walk time between one and two hours (p-val = 0.005) is strongly linked to a high risk taking. On the other hand, a walktime between 30 and 60 minutes seems inversely linked to high risk taking comparing to a longer walk (p-val = 0.004). Finally, going once in a month seems to expose you at an average risk (p-val = 0.012).

Variable / Risk	OR_Average (RC: *Weak*)	P-val$_{Average}$	OR_Strong (RC: *Weak*)	P-val$_{Strong}$
Goes on a walk once a month	2.9	0.012	2.03	0.14
Visit by recommandation	2.45	0.15	3.88	0.03
Walktime between 30 and 60 minutes	0.61	0.21	0.18	0.004
Walktime between 60 and 120 minutes	1.93	0.09	3.43	0.005

Table 10: Results of the univariate logistic regression for the *Risk* dependent variable

4.4.6 Risk taking (Multiple)

Prior to the regression, the walktime between 30 and 60 minutes was removed according to the results of the chi-squared test who checked the links between the input variables. Globally, in table 11, the results are the same than the univariate version but with stronger values.

Variable / Risk	OR_Average (RC: *Weak*)	P-val$_{Average}$	OR_Strong (RC: *Weak*)	P-val$_{Strong}$
Goes on a walk once a month	3.1	0.008	2.33	0.09
Visit by recommandation	2.73	0.11	3.98	0.037
Walktime between 60 and 120 minutes	1.9	0.1	3.3	0.008

Table 11: Results of the multiple logistic regression for the *Risk* dependent variable

All of the Pearson's residual tests returned p-values above the threshold (p-val = 0.05) meaning that all models can be considered as relevant for the analysis.

5 Discussion

5.1 Profiles of walker in the Bois de Lauzelle

We can see that the distribution between men and women indicates that the women seem to be slightly in the majority of walkers. The case of age distribution is different, the profiles that are the most present are the young and the older ones as expected from a city like Louvain-La-Neuve. The official age structure (Figure 24) tells us that the 25-29 age group is the larger which means that we have not a bias by the city distribution because an important part of the walkers surveyed are persons above fifty years old.

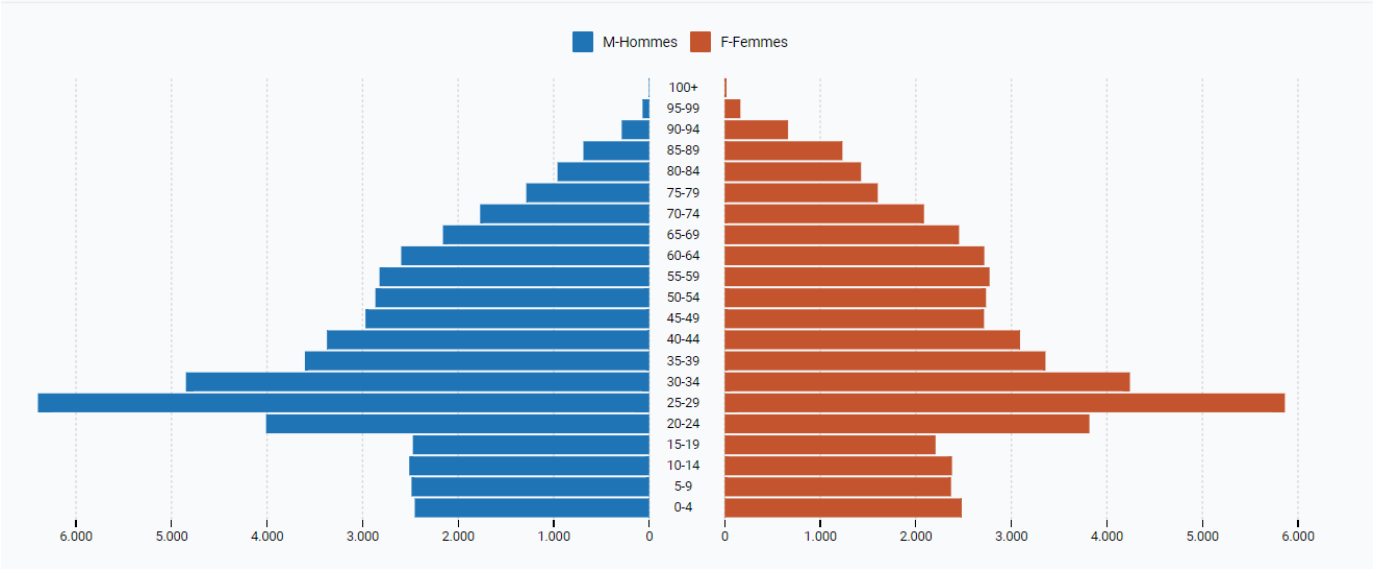

Figure 24: Age structure of Louvain-La-Neuve as of the 1st January 2021 (Statbel, 2022)

The high percentage of people going into the woods to relax can be due to the health context of 2020-2021. The COVID crisis is also known to have caused a lot of stress and anxiety to the population (Dozois, 2021) so it is hard to say if the relaxation is an activity practiced at all times or if the context has an effect on it.

The context has an effect on the frequency however, like discussed for Germany and the USA (Derks et al., 2020, Berry et al., 2021). So seeing that the part of the population who goes on a walk at least once a week is important is not surprising but as our results has shown, a high frequency of walk is linked with only an average knowledge, which means that these new walkers lack of experience.

The Bois de Lauzelle is also very appreciated, the second most answered term for the "reasons to come" question being the quality of the site with 26.1%. This means that people have a positive vision of it. All this even if the proximity for reason to come was expected to be high due to the vast majority of the population coming from Louvain-La-Neuve and its surroundings (Figure 20),

The results for the duration of walk can be explained by what we saw beforehand. The different circuits and the quality of the forest being recognized allows 60% of the walkers to stay more than one hour inside the woods. This is also coherent with the activity practiced, results showing that 50% of the walkers take at least one hour to relax when they come to the woods.

When talking about tick-borne diseases, 86% know the seriousness of these kind of diseases but 56% of the respondents consider it rare. In comparison, Slunge et al. (2019) showed that

people seem to have a high risk perception about TBE, results ranging between 5 and 7 on a scale of 10 although the chances of contracting it are about 2.5% (Hofhuis et al., 2017).

The prevention seems then to be more efficient in northern areas where the right clothes and the use of repellent is more spread than in our study area (clothes: 64% against 45%, repellent: 16% against 12%). The United States have however a big lead in term of repellent use which can be explained by the difficulty of having a good health insurance which drives people to be more cautious generally (Tikkanen et al., 2020). Body checking is the only prevention method that is nearly at the same level, between 50 and 60%, than the Nordic countries and the USA (Jones et al., 2002; Slunge et al., 2018; Jespen et al., 2019).

Even though the risk perception seem to be at the same level between Sweden and Belgium, Belgians uses less ways of protection than them. Slunge et al. (2019) said that there was a low level of knowledge about TBE in Sweden and that this is linked with higher perceived seriousness of tick bites. The way knowledge was noted in Sweden being different than ours, it is hard to compare. But this low knowledge linked to a higher risk perception can explain why more Swedish people use protections.

Our findings show that our level of tick bites (63%) is the double than what was measured in Sweden for the last year (31%) and nearly matches the Swedish number talking about at least one bite during a lifetime (68%) (Slunge et al., 2018). This, what we saw beforehand and the results for the level of knowledge shows that the prevention must rise to prevent more contagion.

5.2 Regression model

5.2.1 Tick Bites

The results of our regression model says that people with cats are more likely to have been bitten than people with dogs or people with no pets. According to British studies, dogs are more likely to be bitten than cats, 54.2% against 32.4%. Masters of dogs may know more about risks than masters of cats (Davies et al., 2017; Abdullah et al., 2016). It is though unsure why owners of cats seem to suffer more tick bites than people with no pets.

We can interpret the relation between the knowledge and the tick bites in two ways. Firstly, the walkers with high knowledge tend to check themselves more and so discover more tick than others and secondly, walkers with high knowledge expose themselves more due to a high confidence in themselves. Seen that we have associate the body checking to a good knowledge during the preparation of the survey, it is safe to say that at least the first hypothesis is correct and that a high knowledge helps us to be more cautious.

The link with hiking is not surprising. This activity encouraging the exploration, it is normal to go offroad and then expose oneself to vegetation and so bites (Schwartz and Goldstein, 1990; Dinc et al., 2017). It is also not surprising to see a low frequency of walk negatively linked to bites given that if there is no walk, there is nearly no chances of being bitten. The link with the stop for chatting is at first more of a surprise but we can assume that when you walk and want to make a stop to talk, you most of the time do not stay in the middle of the road to bother the other walkers. The good manners tells us to empty the way for the others, thereby, being now at the edge of the road and so vegetation, there is higher chances of being exposed to tick bites.

The values listed in table 7 confirm that the discussions and the possession of a cat are more powerful explainers than the others due to their high coefficient without taking away the effectiveness of the others.

5.2.2 Knowledge

The individual results for possession and non-possession of dogs show the same information: owning a dog allow to gather experience from its bites or from the prevention given by the veterinary, information that non-owners do not especially possess. During the multiple regression, the removal of the *No pets* variable emphasize more the observations for the dog possession.

A high frequency of walk could have been a more significant variable but it seems that it is not a perfect match. The p-value is over the threshold of 0.1 that we set so we will not use it as an explainer for a good knowledge. On the other hand, we can see that people who practiced activities close to nature (recreational, observation) seem to know about ticks which is coherent seen that those activities allow to acquire knowledge. Scouting was also include into the recreational activities, seen that it is accepted that there is a high risk of contact scout-tick (De Keukeleire et al., 2015), prevention warnings are given by the organisations to minimize the bites and if bite there is, it will raise their experience as the results show for tick bites in the table 8 in addition to the study of Aenishaenslin et al. (2017).

The results for the stops confirms our interpretations. We first have said that making a stop to chat raises the chance of being bitten, and now we see that chatting is highly linked to a good knowledge which also lead to the noticing of tick bites.

Finally, coming into a forest without knowing much about it (statement made because the visit is on recommendation) is inversely linked to a good knowledge. Someone who came in the forest because someone else told them it is a good place is more likely to not know much about the danger because they are not regular walkers. Inversely, if someone came from really far to the Bois de Lauzelle by recommendation, they might are experienced walkers who wanted to see new landscapes.

5.2.3 Path taken and the risk variable

The value *Risk* is directly linked to the Bois de Lauzelle and so, complicated to apply on other places. The conclusions we can make here is that someone who came by recommendation will want to explore more a place they do not know and so increase their chances of taking a risky road as seen on the table 10. The results for the walktime also follows a certain logic, longer a walk is, higher are the chances of passing through a route considered risky. It is though surprising not to find the variables *0-30* and *More than 120* as they could have confirmed this hypothesis. One explication possible is that in two hours, you have the time of visiting a large part of the forest and so, seen that every crossing was only counted once, there is not much left to explore after that time.

It is important to take into account the bias surrounding the *Risk* variable. Indeed, even if it can lead to numerous interesting observations like the firsts objectives (preferences and risk taking according to other components), the three different circuit and infrastructures all around the woods make this dependent variable less relevant. Those factors may govern the choice of the path that walkers want to take when we wanted to see what habits or knowledge could influence it.

Something that is interesting to verify is the correlation between the circuit predefined and the risky roads. Even though it was stated at the beginning that those observations were subject to change, 31.4% of roads among the circuits have overflowing vegetation and so increase the exposition.

The results on the figure 6 confirms that the infrastructures inside and outside the woods play a big role in the choice of the path, most of the walkers wanting to rejoin the parking, the

hotel or the golf. These areas of high circulations must become one of the most important thing to supervise when talking about the forest maintenance and also spots where the sensitization occurs.

The sampling made by Rousseau et al. (2016) (Annex 9) in the Bois de Lauzelle compared to our frequentation map allow us to see if the most frequented routes are inhabited by ticks. The DON was the higher in SC.2 which is the area nearby the scout's meeting place and which is frequented by 9 to 16% of the walkers. The adults were most found in SC.1 and SC.2. These two sampling areas are located nearby the most popular entrance of the Bois de Lauzelle and so represent a large risk to those who enter by it.

5.3 Study limitation and improvements

5.3.1 Survey

Some new ideas and elements appeared after taking the survey and therefore could not be implemented. Something that came out early was the knowledge about the Lyme disease. The question about it supposed that every walker knew about the existence of the disease by asking if someone they know already had contracted the Lyme borreliosis. We can assume that every yes answer concern someone who actually know the disease but for the people who answered no, it is impossible to say if it is by absence of knowledge or because they really don't know someone who had the Lyme disease.

Even if a question about the knowledge of the Lyme borreliosis was added, it would have been more complete to add also questions about the disease itself. For example, more precise questions about the dangerousness of it or the kind of symptoms that is possible to find, at what state of the contagion and how to treat these symptoms.

More questions about ways of protection and the awareness of prevention campaign could also have been asked to see in more detail how many layers of protection were used by walker and to see if the current prevention campaigns are efficient.

Questions about other activities that can be practiced outside the forest could also have been interesting to know to have more details about the level of exposition undergone by the walkers.

The desire to discuss the COVID-19 context was only had later and so no questions about it were asked. To specify the profiles that need prevention more precisely, it would have been useful to know the differences in habits before and after the lockdown as well as the stress that this period provided and if they were exposed to the coronavirus. It would have been interesting also to differentiate the walkers that go on a walk once a week or more by asking since when they are doing it. This could have help to see which ones came just because of the context or if they are experienced walkers.

It could have been also interesting to interview the forest ranger and ask him about the different methods that he uses or plan to use to upgrade the prevention in the forest. Interviewing him could also have brought some clarifications about the forest maintenance and maybe new stats that he already possesses.

This study focuses on the Bois de Lauzelle in Louvain-La-Neuve but to be able to dress a definitive list of the prevention priority, it would have been useful to do the same survey but with other walkers in other forests. Selecting one forest by region in Belgium and then redo all analysis and push it further may help a lot to understand the habits and the level of knowledge for the whole country. Even locally, it would have been preferable to have more answers but the

limitations of time, planning and helpers made it difficult to increase without a larger team.

Finally, if we are just interested by the knowledge and the habits, An online survey not linked with any circuit in forests could have been made to obtain a lot more of answers. Launching a survey online is far more efficient than waiting for walkers to come and then spend with each individually 10 minutes for the answers when during that time other walkers came inside the forest.

5.3.2 Map

As stated previously, the given map was the optimal method found to allow a maximum of profiles to be considered. However, this method is still tedious and ask walkers commitment during the whole walk, tracing its course as it goes and then return it. This system was not flawless. Firstly, 7.8% of the maps were not clear or even not returned which turn an entire range of data collected via the survey not usable. And secondly, the maps create unconsciously a bias for the route that the walkers took. By giving it to them, they feel forced to stay on tracks (even if they have to) and do not dare to take shortcuts.

In some other places, where the age distribution is not in favor of the older generation, maybe other methods can be then considered. The use of a GPS is still a risky operation (risks of breaking, loosing, etc.) but a good alternative can be the app *Strava*. This app is used by runners and walkers to track their steps and the path that they take. It can even be sent to other users to compare their performances. But like said earlier, this method would not fit here due to the bias that it can create in the age distribution, some elders having more difficulties with technology than others (Eek and Wressel, 2010). A heatmap exists within the application to see the attendance of the roads but is not very clear without a subscription (Annex 10). In the end, the thinking is the same as Godard et al. (2011), the results must be compared with others coming from a passive collecting.

Like mentioned before hand, the summary map (figure 6) is subject to change in the following years. The risky roads can be managed or neglected depending of the season and the workforce and some roads can be closed while other ones will open in order to either be helpful to the wildlife or either maintain the forest.

5.3.3 Statistical analysis

All question's answers were transformed into presence/absence variables though it is normally useful only for the "multiple choices allowed" questions. For example, *Frequency* could have been a variable with multiple modalities and be worked like this. Tests were made to see if the different methods give different results but it is nothing. The values, and so the interpretations stay the same whichever method is choose. As we wanted to show links for each individual modal, this type of display was not retained

5.4 How to improve the prevention ? Who to aim ?

Our results showed that knowledge is effective to spot tick bites and prevent futures infections. The two main profiles that seem to need more prevention are the people who doesn't own any pets and the walker who came by recommendation.

Thanks to Rousseau et al. we were able to compare the density of adult tick/nymph with our frequentation map and found that the frequented entrances in south possess the the higher DON and DOA. Thereby, maintenance should focus on these areas and maintain a vegetation

that does not exceed roads.

It is proved that walking in forests have psychological, cardiac and pulmonary benefits (Song et al., 2018; Lee and Lee, 2014), so continuing to go into wood is a necessity even with the dangers that lies in it. What we can do to secure people who still want to explore woods is educate them. As already done in some entrances in the Bois de Lauzelle, explicative panels can be installed in front of every entrance to explain if the forest we are in possess a population of ticks, and how to minimize the risk of contact. This being already done in the Bois de Lauzelle, we can use the frequentation map to spot the most walked route and add information panels on it. This would help the people who have been recommended, the experienced walkers as well as the new wave of walkers that the COVID-19 outbreak has provided.

The prevention also need to reach hikers and possessors of cat which are profiles that are sensible to tick bites. For the first one, it would be useful that employees who work at shops who sell materials for hiking were formed to explain the risks. Hiking not being representative in the knowledge results, it means that they spot tick bites without necessarily knowing how to remove or so. For the possessors of cats, the easiest way is for the veterinarians to spontaneously inform about what can catch a cat and so what risk the human can be exposed too.

As shown by Aenishaenslin et al. (2016) in Canada, larger campaign on television is very effective and people living in areas not known to have large communities of tick will be able to also learn the dangers lying in the woods.

6 Conclusion

We tried here to find what are the activities that foster the human-tick contact, and so the risk of transmission of the Lyme borelliosis. We showed that what seems like safe actions, can in fact be vectors of risk (ex.: stepping aside on a path to allow others to pass). Even in activities like hiking, where prevention should be mandatory, we see that practitioners are being bitten quite often whereas other close to nature activities like observation seem more safe. This tends to prove that for some of them, prevention is not enough developed and therefore must be a priority.

It was shown that it is difficult to link the knowledge to a reduction of tick bites because statistics affirms that a high level of knowledge is linked to the bites. This was explained by the fact that people with knowledge checks themselves more often after a walk and then find ticks. But our definition of knowledge including ways of protection, we know that they know how to act when they encounter a bite and reduce at maximum the chances of infection. Knowledge seems thus to be only considered when exposed to the menace and not as a prevention to protect ourselves from it.

Knowledge is also very close to experience, profiles having high score being scouts, nature observers or owners of dogs. These profiles have gather experience with ticks, from them or from others, through their activities and so acquired a certain knowledge to face it. This experience seem to work seen that they are not present in our results about tick bites.

Like in most of the entrances of the Bois de Lauzelle, it is necessary to warn the walkers with visible panels of a substantial size at very frequented spots and where the ticks were spotted like nearby the scout's meeting place. In order to orientate the prevention towards the practitioners of the activities at risk, it may be more advised to spread the prevention across points that are frequently used by the supporter of the activity in question like, for example, the different shops that sell material for the hikers. Studies in Canada from Aenishaenslin (2016) showed that large globalized prevention campaigns also work to raise the awareness of the global population.

We saw that like in Sweden, the walkers have an high perception of the risks of tick bites but use less prevention methods even though they know them. Future studies should focus on why some people who know how to protect themselves do not apply those simple rules when they go outside. This would help finding new ways of prevention for those that know, and always think it will never happen to them.

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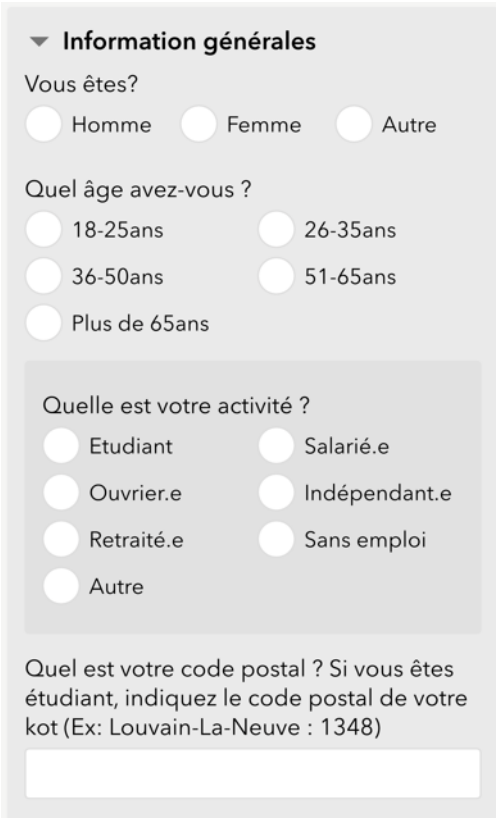
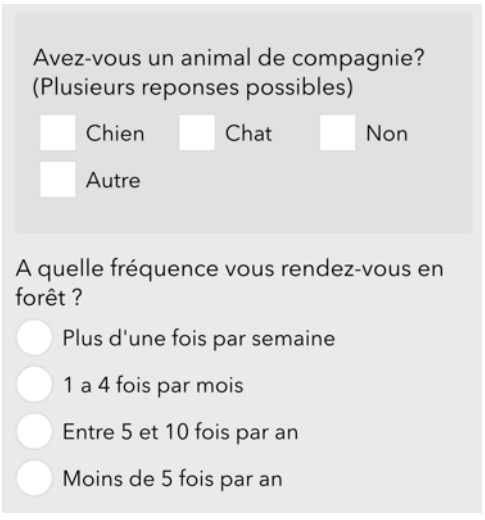
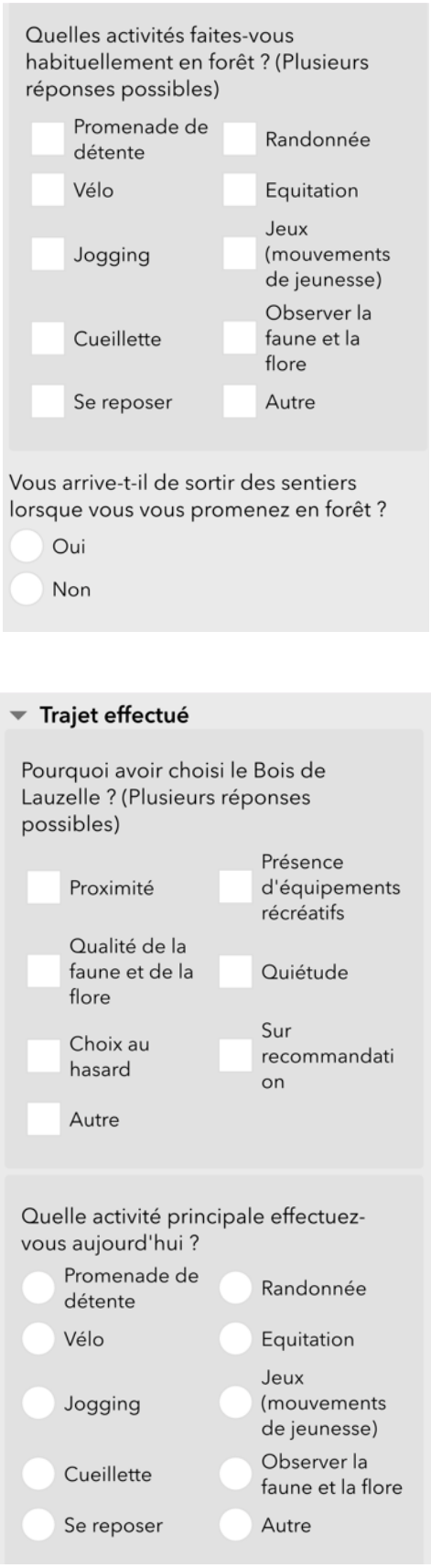
8 Annexes

Annex 1 : Survey






Quelles activités faites-vous habituellement en forêt ? (Plusieurs réponses possibles)
Promenade de détente
Randonnée
Vélo
Equitation
Jogging
Jeux (mouvements de jeunesse)
Cueillette
Observer la faune et la flore
Se reposer
Autre
Vous arrive-t-il de sortir des sentiers lorsque vous vous promenez en forêt ?
Oui
Non
Trajet effectué
Pourquoi avoir choisi le Bois de Lauzelle ? (Plusieurs réponses possibles)
Proximité
Présence d'équipements récréatifs
Qualité de la faune et de la flore
Quiétude
Choix au hasard
Sur recommandation
Autre
Quelle activité principale effectuez-vous aujourd'hui ?
Promenade de détente
Randonnée
Vélo
Equitation
Jogging
Jeux (mouvements de jeunesse)
Cueillette
Observer la faune et la flore
Se reposer
Autre

Avec qui avez-vous réalisé cette activité aujourd'hui ? (Si plusieurs, indiquer le nombre de personnes)

- ○ Seul
- ○ En couple
- ○ En famille sans enfants
- ○ En famille avec enfants
- ○ Avec des ami.e.s/collègue.s

Combien de temps comptez-vous rester en forêt aujourd'hui ?

- ○ Moins de 15 minutes
- ○ Entre 15 et 30 minutes
- ○ Entre 30 minutes et 1 heure
- ○ Entre 1 heure et 2 heures
- ○ Plus de 2 heures
- ○ Sans avis

Comptez-vous effectuer des arrêts ? Si oui, quelle pourrait en être la raison et combien de temps votre pause peut-elle durer ? (Plusieurs réponses possibles)

- ☐ Discussions
- ☐ Observation de la nature
- ☐ Observation des panneaux
- ☐ Repos sur des bancs
- ☐ Repos sur le sol
- ☐ Non
- ☐ Autre

Avez-vous déja été piqué par une tique sur ces 12 derniers mois ?

- ○ Oui
- ○ Non

Selon vous, quelle image représente une tique ?

 1

 2

 3

 4

 5

Selon vous, quelle est la taille d'une tique ? (Plusieurs réponses possibles)

- [ ] Moins d'1mm (Graine de pavot)
- [ ] 1-2mm (Tête d'épingle)
- [ ] 3-4mm (mine de crayon)
- [ ] 5mm ou plus

D'ou tirez-vous vos informations sur les tiques ? (Plusieurs réponses possibles)

- [ ] Journaux/ magazines
- [ ] Télévision/ radio
- [ ] Internet
- [ ] Famille/ Connaissance
- [ ] Médecin/ Spécialiste
- [ ] Autre

A quel moment de l'année sommes-nous le plus susceptible de rencontrer des piqures de tiques ? (Plusieurs réponses possibles).

- [ ] Printemps
- [ ] Eté
- [ ] Automne
- [ ] Hiver
- [ ] Toute l'année

Connaissez-vous quelqu'un ayant déja contracté la maladie de Lyme ?

- ( ) Oui
- ( ) Non

Vous pensez que les maladies liées au tiques sont:

- ( ) Fréquentes et graves
- ( ) Fréquentes et bégnines
- ( ) Rares et graves
- ( ) Rares et bégnines

Utilisez-vous des moyens de prévention pour les piqures de tiques ? A quelle fréquence ?

	Jamais	Rarement	Souvent	Toujours
Répulsifs (Sprays, sticks, pommades)	○	○	○	○
Vêtements à longues manches/ Pantalons longs	○	○	○	○
Rentrer les pantalons dans les chaussettes	○	○	○	○
Vérification régulière et minutieuse du corps après un parcours en forêt	○	○	○	○

Comment retirez-vous habituellement les tiques ? (Plusieurs réponses possibles)

- ☐ A la main
- ☐ Avec une pince à épiler
- ☐ Avec une pince à tique
- ☐ Avec de l'alcool
- ☐ Je n'ai jamais retiré de tiques
- ☐ Autre

Annex 2 : Consent paper

ID _ _ _

Université catholique de Louvain (UCLouvain) –
Centre Georges Lemaître de recherche sur la Terre et le Climat

FORMULAIRE D'INFORMATION ET DE CONSENTEMENT À L'ENQUÊTE :
EXPOSITION DES PROMENEURS ET PROMENEUSES
AUX PIQURES DE TIQUES AU BOIS DE LAUZELLE

Cette courte enquête (10 minutes max.) prend place dans le cadre d'une recherche sur l'exposition aux piqures de tiques en forêt. Les milieux forestiers sont de plus en plus recherchés pour leur quiétude, la présence d'une faune et d'une flore variées, pour la pratique d'activités sportives et de loisirs, ou tout simplement pour s'évader dans la nature. Les effets positifs des forêts sur la santé sont depuis longtemps démontrés et reconnus. Néanmoins, les séjours en forêt comprennent aussi des risques pour la santé, notamment celui de se faire mordre par des tiques. Celles-ci se retrouvent généralement dans la végétation et peuvent transmettre des maladies (dont la maladie de Lyme). Une petite partie des tiques sont infectées, mais il faut faire attention en forêt, et ne pas adopter de comportements à risque.

Avec cette enquête, vous allez aider améliorer la prévention sur les maladies transmises par les tiques. Elle comporte trois parties. La première identifie le chemin que vous avez parcouru dans le bois de Lauzelle. La deuxième collecte des informations sur vos habitudes liées à la forêt. La dernière partie sert à évaluer votre connaissance et vos expériences précédentes avec les tiques, pour voir l'un impact sur votre comportement en forêt.

En participant à cette enquête, vous donnez votre consentement à ce que les informations recueillies soient utilisées dans cette étude. Avant de participer, lisez attentivement le texte ci-dessous. Attention, vous devez être majeur·e pour participer à cette enquête.

Il n'y a aucune obligation relative à la participation à cette enquête. Vous pouvez mettre fin à votre participation à tout moment. Toutes les informations communiquées seront collectées et traitées de manière anonyme, et seront traitées uniquement dans le cadre de cette recherche. Toute présentation des traitements des données se fera de manière agrégée. Aucune information individuelle ne sera divulguée dans la présentation des résultats ni transmise à des tiers. La base de données anonymes sera conservée pour la durée de la recherche, conformément au Règlement 2016/679 du Parlement européen et du Conseil du 27 avril 2016 relatif à la protection des personnes physiques à l'égard du traitement des données à caractère personnel et à la libre circulation de ces données, et abrogeant la directive 95/46/CE et à la loi du 30 juillet 2018 relative à la protection des personnes physiques à l'égard des traitements de données à caractère personnel.

L'ID de 3 chiffres situé en haut à droite de cette page vous servira à nous communiquer à **https://forms.gle/ZioExYWgm85PPWG47** si vous avez ou pas été piqué par une tique durant votre trajet. Vous êtes libres de demander la suppression de vos données, en nous faisant la demande et communiquant votre ID aux adresses ci-dessous.

Nous nous tenons également à votre disposition pour toute remarque ou renseignement complémentaire,

Étudiant : Martin Couck (martin.couck@student.uclouvain.be)
Chercheur : Raphaël Rousseau (raphael.rousseau@uclouvain.be)
Promotrice : Sophie Vanwambeke (sophie.vanwambeke@uclouvain.be)

Annex 3 : Prevention flyer

SURVEILLER

Que faire après une morsure ?

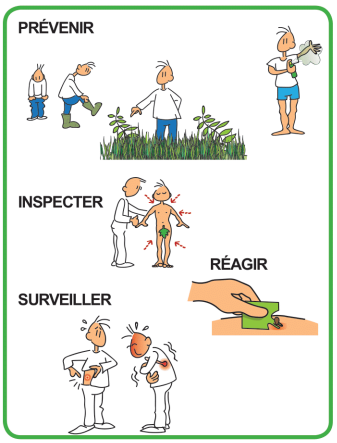
o Rester serein :

1. Un nombre limité de morsures est infectant;
2. Une tique infectée ne transmet pas nécessairement une maladie;
3. La maladie de Lyme, maladie pouvant être transmise via les morsures de tiques, peut être traitée de manière efficace avec des antibiotiques.

o Signaler la morsure sur le site :
tiquesnet.wiv-isp.be
Pour vous aider à vous souvenir de la date de morsure, inscrivez-la ici : .....

o La zone de morsure doit être surveillée pendant 30 jours afin d'exclure l'apparition d'un érythème migrant (photo).

o Prendre contact rapidement avec le médecin traitant si la tique n'a pu être enlevée correctement ou si on constate un érythème migrant ou des symptômes grippaux.



Contacts utiles

AVIQ – Cellule de surveillance des maladies infectieuses

E-mail: surveillance.sante@aviq.be
Rue de la Rivelaine 21 - 6061 Charleroi

Tél: +32(0)71/33.71.09

Avec la collaboration de

sciensano

Ed. responsable A. Baudine - Rue de la Rivelaine, 21 - 6061 Charleroi - Numéro de dépôt légal : D/2019/7646/22

TIQUES

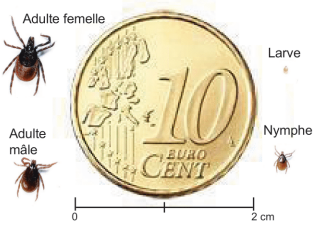
Wallonie familles santé handicap AVIQ

AVIQ Santé

PRÉVENIR

C'est quoi une tique ?

Une tique est un petit acarien de couleur brun-noir et de la taille d'une tête d'épingle.



Quels sont les risques liés aux tiques ?

Les tiques peuvent être vecteurs de maladies comme par exemple la maladie de Lyme (maladie à transmission vectorielle la plus répandue dans les régions tempérées).

Quand être attentif ?

o **Particulièrement de mars à octobre**

o Les tiques se retrouvent essentiellement dans des endroits ombragés envahis par les broussailles, les fougères, les herbes hautes, etc.
On les trouve en abondance dans des forêts, bois et réserves naturelles. La plupart des morsures de tiques surviennent donc lors d'une promenade en forêt, mais également dans des prairies, des dunes, des espaces verts urbains et dans les jardins.

Comment éviter les morsures ?

o Rester sur des sentiers battus, en évitant le contact avec les buissons et les herbes hautes.

o Porter des vêtements couvrants les bras et les jambes, ainsi que des chaussures fermées, en mettant le pantalon dans les chaussettes.
En période estivale, cette recommandation est difficilement applicable et dans ce cas, un répulsif type DEET 30 à 50% peut être utilisé sur la peau exposée, en évitant le visage et les mains. L'application du répulsif doit être renouvelée toutes les 2 à 3 heures.

o Le port de vêtements clairs permet de repérer plus rapidement les tiques non encore fixées sur la peau.

INSPECTER

Que faut-il vérifier ?

Après chaque exposition potentielle à des tiques (promenade, jardinage), contrôler la peau pour vérifier qu'aucune tique ne s'y soit fixée. La recherche de la tique doit se faire sur tout le corps en insistant sur les zones de plis, la tête, derrière les oreilles et le cou en particulier chez les enfants.

RÉAGIR

Comment enlever ?

o La tique doit être retirée le plus rapidement possible avec une carte ou une pince à tiques (exemples voir photo) positionnée le plus près possible de la peau sans comprimer le corps de la tique : pas d'éther, alcool ou vaseline !

o La zone de morsure doit être désinfectée.

Annex 4 : Code

```
library(mlogit)
library(car)
library(perturbR)
setwd("~/Cours/G o/Master_2/M moire/Tables␣Excel")

Bdl_cat <- read.csv(file = "BDL_Clear_4.csv", sep = ";", dec = ",", header = TRUE)

Bdl_cat$Niveau_Savoir <- relevel(Bdl_cat$Niveau_Savoir,ref="Faible")

Bdl_cat <- Bdl_cat[,-2]
Bdl_cat <- Bdl_cat[,-1]

table(Bdl_cat$Risque)
table(Bdl_cat$Niveau_Savoir)
table(Bdl$Piqure)

table(Bdl_cat$Act_detente, Bdl_cat$Temps_120)

#3 variables    expliquer : Risques, connaissances et piqures
#2 types de variables explicatives: cat gorielles et de comportement

Var <- c("Risque", "Sexe_homme", "Sexe_femme", "Age_18_25", "Age_26_35",
         "Age_36_50", "Age_51_65", "Age_65plus", "Occ_Etudiant",
         "Occ_Salarie", "Occ_Inde", "Occ_Retrait",
         "Ville", "Animal_Chien", "Animal_chat", "Animal_non", "Freq_week",
         "Freq_month", "Freq_less_month", "Act_detente", "Act_Jogging",
         "Act_jeux", "Act_Observer", "Act_rando",
         "Act_velo", "Act_repos", "Azimut", "Prq_calme", "Prq_Proxi",
         "Prq_quali", "Prq_recom",
         "Prq_hasard", "Qui_seul", "Qui_amis", "Qui_couple", "Qui_famille",
         "Temps_0_30", "Temps_30_60", "Temps_60_120", "Temps_120",
         "Arrets_Nat", "Arrets_Discu",
         "Arrets_bancs", "Arrets_pan", "Arrets_non", "Niveau_Savoir", "Piqure")
#Risque

#contingence
sink(file='contingence_risque.txt')
for (i in 1:length(Var)){
  Table <- table(Bdl_cat$Risque, Bdl_cat[,colnames(Bdl_cat) == Var[i]])
  Table <- as.data.frame.matrix(Table)
OR1 <- (Table[1,2]/(Table[2,2]+Table[3,2]))/
  (Table[1,1]/(Table[2,1]+Table[3,1]))

OR2 <- (Table[2,2]/(Table[1,2]+Table[3,2]))/
  (Table[2,1]/(Table[3,1]+Table[1,1]))

OR3 <- (Table[3,2]/(Table[1,2]+Table[2,2]))/
  (Table[3,1]/(Table[2,1]+Table[1,1]))

  OR <- c(OR1, OR2, OR3)
```

```
  Table2 <- cbind(Table, OR)
  print (Var[i])
  print(Table2)
  print(chisq.test(Table))
}
sink()

  #Boxplots
for (i in 1:length(Var)) {
  png(file = paste("Risque_",Var[i] , ".png", sep=""))
  boxplot(Bdl$Risque ~ Bdl[,colnames(Bdl) == Var[i]])
  dev.off()
}


#Regression logistique
sink(file='Reglog_risque.txt')
for (i in 1:length(Var)){
  log <- glm(Bdl_cat$Risque ~ Bdl_cat$Niveau_Savoir, data =Bdl_cat,
             family = "binomial")
  print (Var[i])
  print(summary(log))
  print (exp(coef(log)))
}
sink()
plot(log)
    #Freq_month, prq_recom, prq_hasard, temps_30_60, temps_60_120



sink(file='Reglogmulti_risque.txt')
for (i in 1:length(Var)){
  Bdl_cat_T <- mlogit.data(Bdl_cat, shape = "wide", choice = "Risque")
  mlreg1 <- mlogit(Risque ~ 1 | Bdl_cat_T[,colnames(Bdl_cat_T) == Var[i]] ,
                   data = Bdl_cat_T,
                   reflevel = "Faible")
  print (Var[i])
  print(summary(mlreg1))
  print (exp(coef(mlreg1)))

  s2 = sum(residuals(mlreg1, type = "pearson")^2)
  ddl = df.residual(mlreg1)
  pvaleur = 1 - pchisq(s2, ddl)
  print(pvaleur)
}
sink()



  #Regression Logistique multiple
binomial<- glm(as.factor(Risque) ~ Freq_month+Prq_recom+Temps_30_60+Temps_60_120,
               data =Bdl_cat, family = "binomial")
Probabilite <- data.frame(Bdl_cat$Risque, Bdl_cat$Freq_month, Bdl_cat$Prq_recom,
```

```
                                Bdl_cat$Temps_30_60,
                                Bdl_cat$Temps_60_120,predit
                                = binomial$fitted.values)
head(Probabilite, n = 5)


Bdl_cat_T <- mlogit.data(Bdl_cat, shape = "wide", choice = "Risque")
mlreg1 <- mlogit(Risque ~ 1 | Freq_month+Prq_recom+Temps_30_60+Temps_60_120,
                 data = Bdl_cat_T,
                 reflevel = "Faible")
summary(mlreg1)
print (exp(coef(mlreg1)))

chisq.test(Bdl_cat$Prq_recom, Bdl_cat$Temps_60_120)

s2 = sum(residuals(mlreg1, type = "pearson"))
ddl = df.residual(mlreg1)
pvaleur = 1 - pchisq(s2, ddl)
pvaleur


#Savoir

#contingence
sink(file='contingence_savoir.txt')
for (i in 1:length(Var)){
  Table <- table(Bdl_cat$Niveau_Savoir, Bdl_cat[,colnames(Bdl_cat) == Var[i]])
  Table <- as.data.frame.matrix(Table)

    OR1 <- (Table[1,2]/(Table[2,2]+Table[3,2]+Table[4,2]))/
      (Table[1,1]/(Table[2,1]+Table[3,1]+Table[4,1]))

    OR2 <- (Table[2,2]/(Table[1,2]+Table[3,2]+Table[4,2]))/
      (Table[2,1]/(Table[3,1]+Table[1,1]+Table[4,1]))

    OR3 <- (Table[3,2]/(Table[1,2]+Table[2,2]+Table[4,2]))/
      (Table[3,1]/(Table[2,1]+Table[1,1]+Table[4,1]))

    OR4 <- (Table[4,2]/(Table[1,2]+Table[2,2]+Table[3,2]))/
      (Table[4,1]/(Table[2,1]+Table[1,1]+Table[3,1]))

  OR <- c(OR1, OR2, OR3, OR4)
  Table2 <- cbind(Table, OR)
  print (Var[i])
  print(Table2)
  print(chisq.test(Table))
}
sink()

  #Boxlots
for (i in 1:length(Var)) {
  png(file = paste("Savoir_",Var[i] , ".png", sep=""))
  boxplot(Bdl$Niveau_Savoir ~ Bdl[,colnames(Bdl) == Var[i]])
```

```
  dev.off()
}

  #Regression logistique
sink(file='Reglog_savoir.txt')
for (i in 1:length(Var)){
  log <- glm(Bdl_cat$Niveau_Savoir ~ Bdl_cat[,colnames(Bdl_cat) == Var[i]],
             data =Bdl_cat, family = "binomial")
  print (Var[i])
  print(summary(log))
  print (exp(coef(log)))
}
sink()
    #Animal_chat, Act_velo, Azimut, Prq_calme, Prq_recom, Qui_amis,
#Arrets_Discu, Piqure

sink(file='Reglogmulti_savoir.txt')
for (i in 1:length(Var)){
Bdl_cat_T <- mlogit.data(Bdl_cat, shape = "wide", choice = "Niveau_Savoir")
mlreg1 <- mlogit(Niveau_Savoir ~ 1 | Bdl_cat_T[,colnames(Bdl_cat_T) == Var[i]] ,
                 data = Bdl_cat_T,
                 reflevel = "Faible")
print (Var[i])
print(summary(mlreg1))
print (exp(coef(mlreg1)))

s2 = sum(residuals(mlreg1, type = "pearson")^2)
ddl = df.residual(mlreg1)
pvaleur = 1 - pchisq(s2, ddl)
pvaleur
}
sink()
table(Bdl_cat$Niveau_Savoir)

#reg multinomiale

binomial<- glm(as.factor(Niveau_Savoir) ~ Animal_Chien+Animal_non+Freq_week+
                 Act_jeux+Act_Observer+
                 Prq_calme+Prq_recom+Arrets_Discu+ Piqure,
               data =Bdl_cat, family = "binomial")

Bdl_cat_T <- mlogit.data(Bdl_cat, shape = "wide", choice = "Niveau_Savoir")
mlreg1 <- mlogit(Niveau_Savoir ~ 1 | Animal_Chien+Animal_non+Freq_week+Act_jeux+
                   Act_Observer+
                   Prq_calme+Prq_recom+Arrets_Discu+ Piqure,  data = Bdl_cat_T,
                 reflevel = "Faible")
summary(mlreg1)
print (exp(coef(mlreg1)))

chisq.test(Bdl_cat$Animal_Chien, Bdl_cat$Animal_non)

vif(binomial)
```

```
s2 = sum(residuals(mlreg1, type = "pearson")^2)
ddl = df.residual(mlreg1)
pvaleur = 1 - pchisq(s2, ddl)
pvaleur

#Piqure

  #contingence
sink(file='contingence_piqure.txt')
for (i in 1:length(Var)){
  Table <- table(Bdl_cat$Piqure, Bdl_cat[,colnames(Bdl_cat) == Var[i]])
  Table <- as.data.frame.matrix(Table)

    OR1 <- (Table[1,2]/(Table[2,2]))/(Table[1,1]/(Table[2,1]))

    OR2 <- (Table[2,2]/(Table[1,2]))/(Table[2,1]/(Table[1,1]))

  OR <- c(OR1, OR2)
  Table2 <- cbind(Table, OR)
  print (Var[i])
  print(Table2)
  print(chisq.test(Table))
}
sink()

  #Boxplots
for (i in 1:length(Var)) {
  png(file = paste("Piqure_",Var[i] , ".png", sep=""))
  boxplot(Bdl$Piqure_cb ~ Bdl[,colnames(Bdl) == Var[i]])
  dev.off()
}


#Regression logistique
sink(file='Reglog_piqure.txt')
for (i in 1:length(Var)){
  log <- glm(Bdl_cat$Piqure ~ Bdl_cat[,colnames(Bdl_cat) == Var[i]],
             data =Bdl_cat, family = "binomial")
  print (Var[i])
  print(summary(log))
  print (exp(coef(log)))
}
sink()
    #Animal_chat, Freq_less_month, Act_rando, Arrets_Nat, Arrets_Discu,
#Savoir Faible et moyen


  #Regression Logistique multiple
binomial<- glm(as.factor(Piqure) ~ Animal_chat+Freq_less_month+Act_rando+
                 Arrets_Discu+Niveau_Savoir,
               data =Bdl_cat, family = "binomial")
summary(binomial)
print (exp(coef(binomial)))
```

```
Probabilite <- data.frame(Bdl_cat$Piqure,Bdl_cat$Freq_less_month,
                          Bdl_cat$Animal_chat,Bdl_cat$Act_rando,
                          Bdl_cat$Arrets_Nat,Bdl_cat$Arrets_Discu,
                          Bdl_cat$Niveau_Savoir,predit
                          = binomial$fitted.values)
head(Probabilite, n = 5)

vif(binomial)
typeof(Bdl_cat$Freq_less_month)

s2 = sum(residuals(binomial, type = "pearson")^2)
ddl = df.residual(binomial)
pvaleur = 1 - pchisq(s2, ddl)
pvaleur
```

Annex 5 : Descriptive results of profiles

Variable	Percentage
Gender	
Male	46.4
Female	53.59
Other	0.65
Age	
18-25	28.1
26-35	14.4
36-50	16.3
51-65	28.1
Over65	13.1
Occupation	
Student	24.2
Employee	40.5
Independent	11.8
Retired	19.6
Possession of a pet	
Dog	34
Cat	20.3
No pets	48.4

Annex 6 : Descriptive results of habits

Variable	Percentage
Frequency	
Once a week or more	52.3
At least once a month	32.7
Less than once a month	15
Activity	
Relaxation	86.9
Jogging	22.2
Recreation	7.8
Observation	28.1
Hiking	26.8
Biking	11.8
Rest	7.2
Azimut	44.4
Reason	
Calm	23.5
Proximity	68
Quality	26.1
Recommendation	15
Random	13.7
With whom ?	
Friend	20.3
Partner	21.5
Family	20.9
Alone	37.2
Duration of the walk	
0-30 minutes	11.8
30-60 minutes	27.4
60-120 minutes	47
More than 120 minutes	12.4
Stops	
Observation of nature	30.7
Chatting	11.1
Benches	33.3
Read panels	9.8
No halts	43.1

Annex 7 : Descriptive results of knowledge

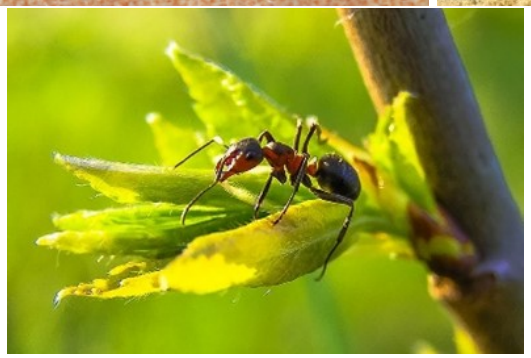
Variable	Percentage
Photography	
Spider	0.65
Bug	5.19
Tick	89.6
Dung Beetle	3.9
Ant	0.65
Origin of knowledge	
Internet	37.5
Doctor/specialist	24
Magazines/books	14.9
Television	11
Own experience	37.66
Experience from others	44.2
Reason	
Calm	23.5
Proximity	68
Quality	26.1
Recommendation	15
Random	13.7
Seriousness of tick-borne diseases	
Rares serious	51.3
Rares benign	5.2
Frequent serious	35
Frequent benign	8.4
Tick removal	
Tick tweezers	63.6
Tweezers	21.4
Bare hands	8.4
Alcohol	14.3
Other	8.4

Ways of protection	Never	Rarely	Often	Always
Repulsives	75.3	11	9.1	2.6
Long clothes	40.9	13.6	26	19.5
Pants in socks	74	13.6	8.4	3.9
Body checking	31.2	15.6	25.3	26

Annex 8 : Pictures shown during the survey

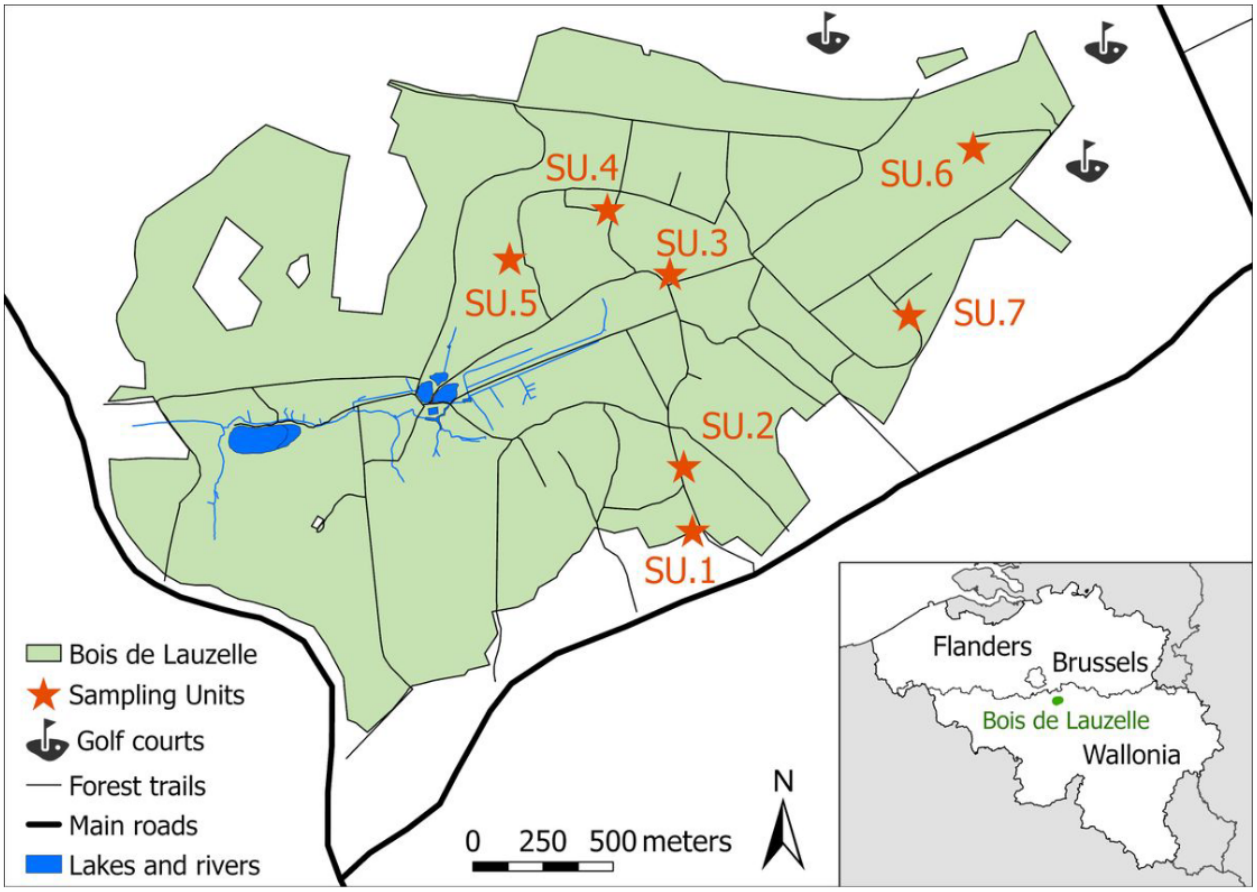






Source : Pixabay.be, 2021

Annex 9 : Sampling areas made by Rousseau et al. (2016)



Annex 10 : Strava's heatmap on the Bois de Lauzelle

If you want to contact me for questions about the making of this study or other, you can do it at:

Mail: martin.couck@gmail.com

GSM : +32487392212

Address : Bd Charles Van Péé, 43 1400 Nivelles, Belgium

UNIVERSITÉ CATHOLIQUE DE LOUVAIN
Faculté des sciences
Place des sciences, 2 bte L6.06.01, 1348 Louvain-la-Neuve, Belgique | **www.uclouvain.be/sc**