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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Scholarship 2024
Statistics

Time allowed: Three hours
Total score: 32

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

Pull out Formulae and Tables Booklet S–STATF from the centre of this booklet.

Show ALL working.

Check that this booklet has pages 2–24 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (////). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Question	Score
ONE	
TWO	
THREE	
FOUR	
TOTAL	

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QUESTION ONE

FluTracking is a surveillance system that harnesses both the power of the internet and community spirit for monitoring influenza. Each week, over 110 000 volunteer participants in New Zealand and Australia fill in an online survey about their illness symptoms during the previous week, including whether they have experienced the following:

- fever
- cough
- sore throat
- runny nose
- shortness of breath
- any change in sense of taste or smell
- headache.

(a) Figure 1 shows the incidence rate of participants in New Zealand who reported having both a fever and a cough during the surveyed week.

Figure 1: FluTracking New Zealand weekly fever and cough symptoms (%) 2023

Adapted from: www.flutracking.net/Info/Report/202353/NZ

(i) Write one short paragraph describing the key features of the data for the incidence of fever and cough symptoms over the period April 2019 to December 2023.

(ii) Discuss THREE possible limitations of the study design used by FluTracking, including the impact of the design on any conclusions that could be made.

(b) FluTracking releases weekly reports for both Australia (Figure 2) and New Zealand (Figure 3). These reports include a breakdown of symptoms by age group.

Figure 2: FluTracking Australia weekly fever and cough symptoms (%) by age group 2021–2023

Adapted from: www.flutracking.net/Info/Report/202353/AU

Figure 3: FluTracking New Zealand weekly fever and cough symptoms (%) by age group 2023

Adapted from: www.flutracking.net/Info/Report/202353/NZ

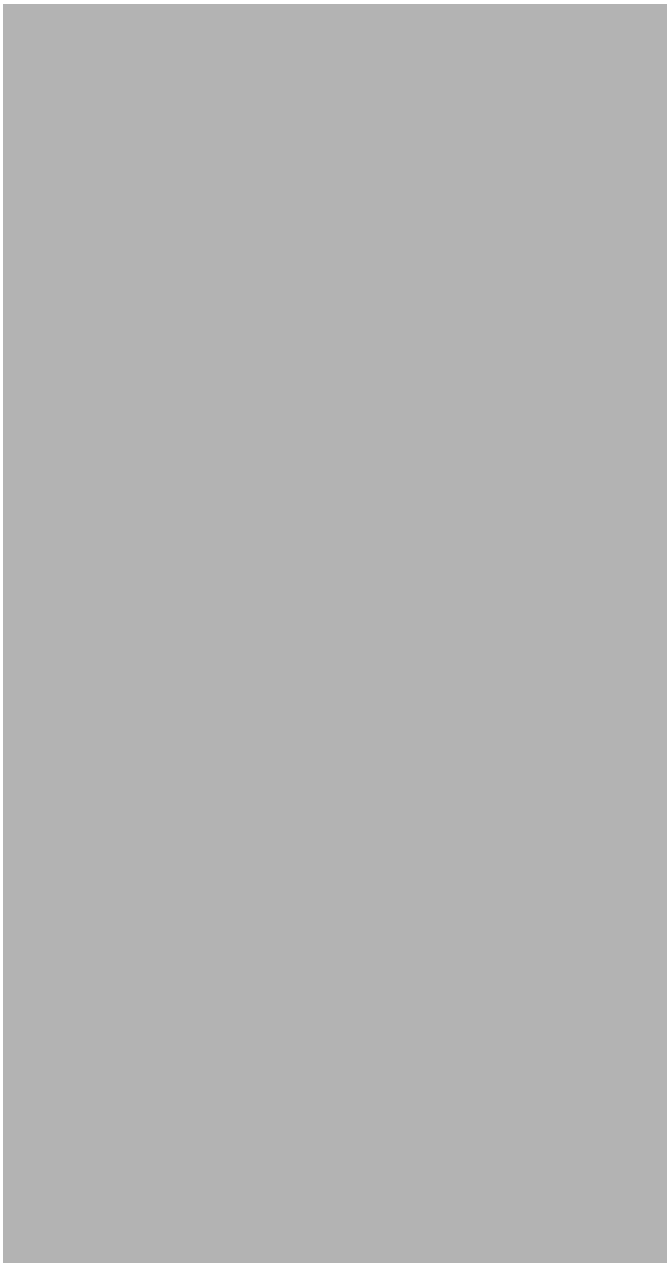
Use Figure 2 and Figure 3 to make THREE statements that compare the incidence of fever and cough in different age groups between the two countries.

(c) In order to quantify the risk factors of influenza transmission in households, a prospective study was conducted during the 1999 / 2000 winter season in France.

946 households were enrolled in the study, where one member of the household, the index patient, had visited their doctor because of an influenza-like illness. 510 of the index patients tested positive for Influenza A. Secondary cases of influenza among household contacts of the index patients were identified using a standardised daily questionnaire over a period of 15 days.

Secondary cases were defined as household contacts who had gone on to develop clinical influenza within 5 days of the disease onset in the index patient. 395 households completed the questionnaire, of which 116 were excluded. Figure 4 describes the study design.

Figure 4: Study Design (1999–2000 Winter Influenza Season in France)



Adapted from: Viboud, C. et al (2004), Risk factors of influenza transmission in households, *The British Journal of General Practicioners,* 54(506):684-89

(i) In the 279 households that met the study criteria, the mean number of children under 15 years of age per household was 0.71.

Calculate an estimate of the number of children under 15 who were recorded as secondary cases in this study.

(ii) Discuss any issues that may influence the accuracy of your estimate in part (c)(i).

QUESTION TWO

There are over 200 different viruses that can cause colds. These viruses spread through the air when someone with a cold sneezes or coughs. Once cold symptoms begin, they will usually be resolved within a week.

(a) A study on the duration of symptoms of the common cold virus was undertaken across Auckland. A researcher conducted an online survey of 620 volunteer participants. Each participant was asked to report the duration of their most recent cold symptoms from onset, also known as day 0. Of the 620 participants in the study, 121 experienced a fever and 612 experienced a sore throat, while 8 participants did not experience either of these symptoms.

Figure 5 shows the density distributions of the duration of fever and sore throat symptoms reported by study participants.

Figure 5: Density distributions of the duration of fever and sore throat symptoms in days

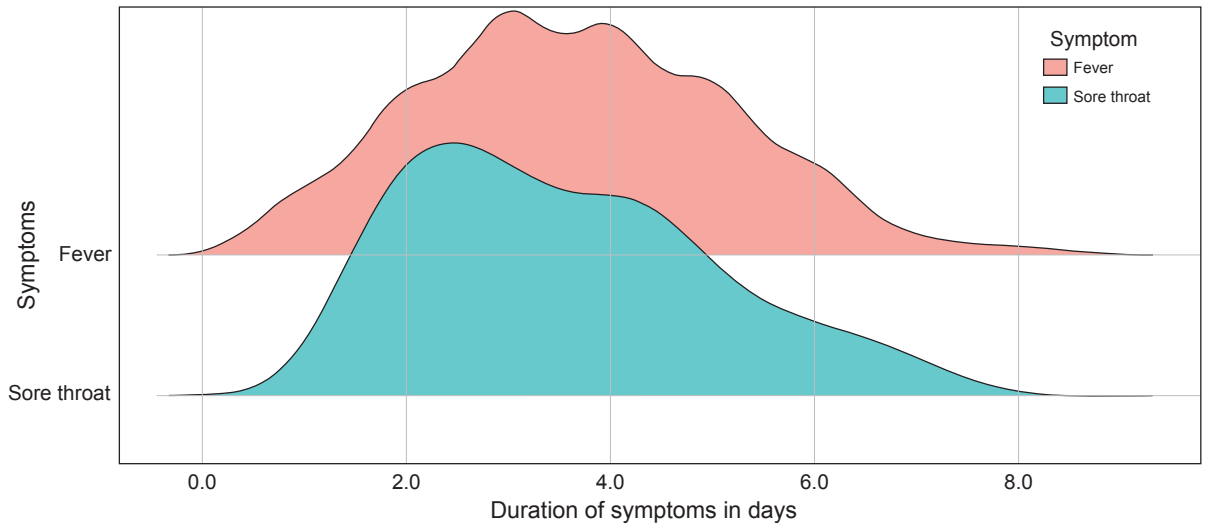
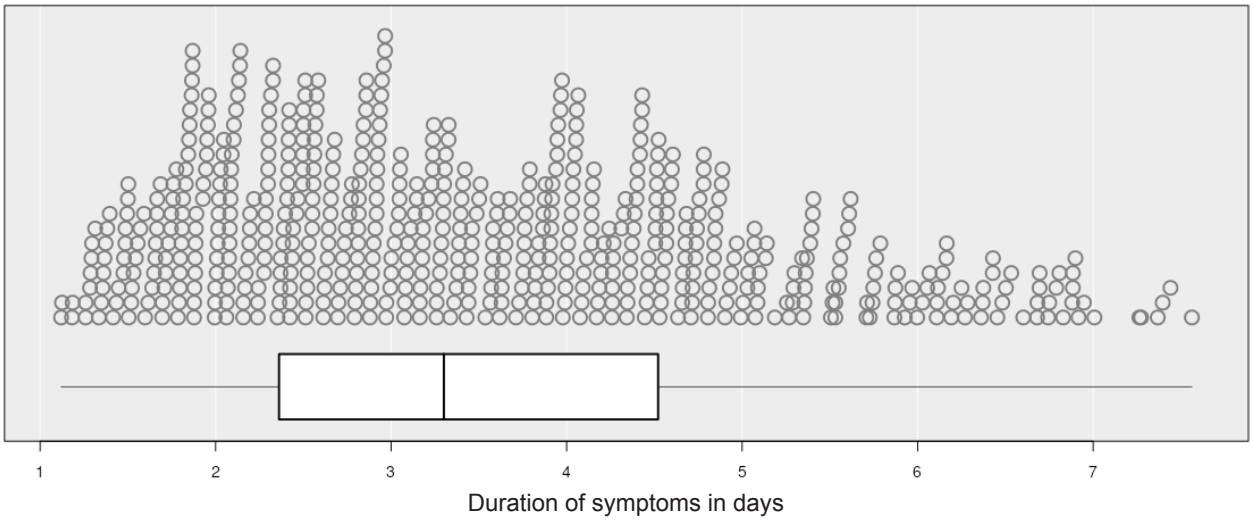


Figure 6 shows the sore throat symptoms, in days, reported by study participants.

Figure 6: Sore throat symptoms in days



Min	25%	Median	75%	Max	Mean	SD	Sample Size
1.12	2.361	3.3	4.521	7.563	3.536	1.471	612

(i) Suggest a suitable probability distribution model, including relevant parameters, to model the duration of fever symptoms.

Comment on the limitations of the probability distribution model you have chosen.

(ii) It has been suggested that the duration of sore throat symptoms can be modelled by a triangular distribution with the parameters a:1, b:7, c:2.

Using the data and information provided in Figure 6, discuss whether the proposed probability distribution model is appropriate.

Use probability calculations to support your answer.

(b) Minimum sick leave entitlements in New Zealand increased from 5 days per year to 10 days per year from 24 July, 2021. Paid sick leave can be taken by employees when they, or a dependent family member, are unwell. If an employee uses all their available sick leave entitlements, they may take further sick leave as unpaid leave, annual holiday leave, or as sick leave in advance.

The Workplace Wellness Report 2023 surveyed 137 businesses employing 135 742 people across New Zealand. One of the questions in the survey asked for the number of days taken by employees as sick leave in the previous year 2022. Figures showed that in 2022, employees of these businesses took an average of 5.6 whole days sick leave per person. This was an increase of 1.2 days above the average for 2012.

Table 1: Sick leave entitlements and average sick leave taken 2012 and 2022.

	Yearly sick leave entitlement	**Average sick leave taken**
2012	5 days	4.4 days
2022	10 days	5.6 days

(i) Using the Poisson distribution model and information provided in Table 1, compare an estimate for the probability that an employee exceeded their yearly sick leave entitlement in 2012, with an estimate for the probability of exceeding their entitlement in 2022.

(ii) Discuss TWO potential issues with using the Poisson distribution model with this data.

(c) A health student from Otago University wanted to investigate whether New Zealanders who were unwell were more likely to take time off from their regular duties, such as work or school, in the winter months compared with the summer months. They conducted two online surveys of randomly sampled New Zealanders in August 2023 (winter) and January 2024 (summer), and asked respondents whether they had experienced an influenza-like illness (a fever with a cough or a sore throat) during the previous month.

The respondents who had experienced an influenza-like illness were then asked an additional question about whether this illness resulted in them being absent from their regular duties. The results of the second question for both surveys is displayed in Table 2 below.

Table 2: Absence from regular duties due to influenza-like illness (ILI)

	Absent from regular duties due to ILI	**Not absent from regular duties despite ILI**
July 2023	1434	670
December 2023	519	275

Construct a confidence interval and use it to evaluate the claim that New Zealanders with an influenza-like illness are more likely to take time off from their regular duties in the winter months than in the summer months.

QUESTION THREE

(a) Asthma is one of the most common illnesses in New Zealand, affecting an estimated 1 in 8 New Zealand adults, and 1 in 7 New Zealand children. There is no cure, but recent advances in medication may improve outcomes for asthma sufferers.

Report 1: Study a 'game-changer' for treating Kiwi asthma sufferers

Adapted from: www.stuff.co.nz/national/health/112844094/study-a-gamechanger-for-treating-kiwi-asthma-sufferers

(i) Write a short paragraph that identifies the key elements of the study design using appropriate statistical terminology.

(ii) Discuss TWO reasons researchers randomly allocated participants into one of the three groups: reliever only, reliever and separate preventer, combined preventer-reliever.

(iii) The study in Report 1 was an open-label trial; there was no blinding, and participants were aware of what medication they were taking. Previous studies were double-blinded and all participants were provided with two inhalers. Participants in the double-blinded studies were randomly allocated into one of three treatment groups:

- active reliever inhaler and placebo preventer inhaler
- active reliever inhaler and separate active preventer inhaler
- active combined preventer-reliever inhaler and placebo preventer inhaler

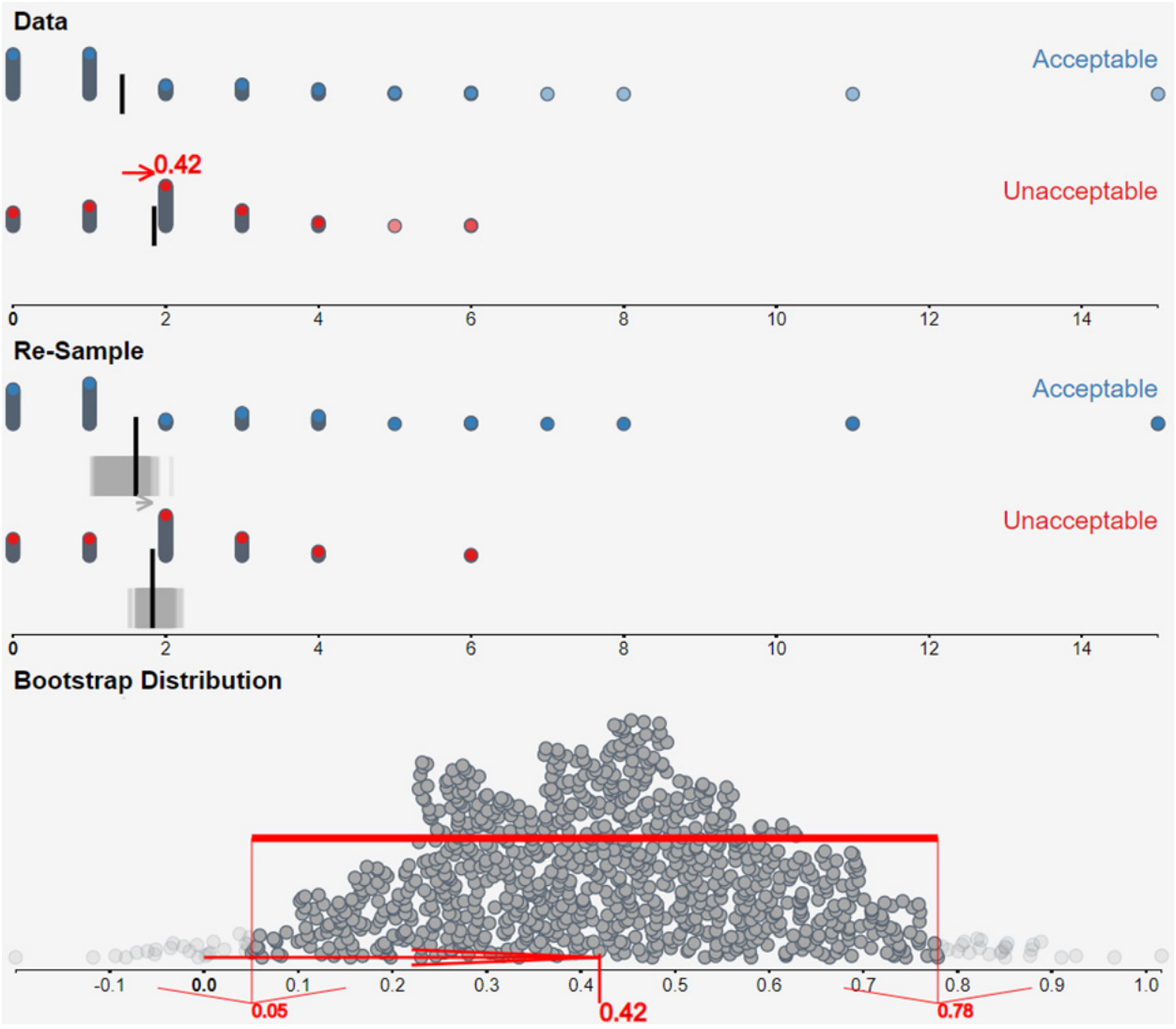
Discuss why researchers may have chosen not to blind the study in Report 1.

(b) The New Zealand Healthy Homes insulation standard requires all rental homes to have suitable ceiling and underfloor insulation by 1 July 2025. Adequate insulation results in homes that are warmer, drier, and less prone to mould. The Asthma and Respiratory Foundation of New Zealand recommends that all New Zealand homes be insulated to this standard to help keep those with asthma well, and to minimise their symptoms and potential complications with the illness.

In January 2024, results from a random sample of 2000 rental properties in Otago, Canterbury and the West Coast showed that 12.5% of the occupants in the rental properties surveyed were currently taking medication for asthma. The survey respondents were asked whether they believed their property met the current Healthy Homes insulation standard for both ceiling and underfloor insulation, as well as how many asthma-related healthcare visits each household member made during 2023.

The survey data for household occupants who were currently taking medication for asthma was analysed further. This data was used to construct a bootstrap confidence interval (Figure 7) for the difference between the mean number of healthcare visits by those who live in rental homes with acceptable insulation, and by those with unacceptable insulation.

Figure 7: Bootstrap distribution test output



Discuss what can be concluded from both the features of the sample data distributions and the confidence interval constructed using the sample data, including any reservations you may have about extending any findings from the results.

(c) In Uganda, large-scale population data on the prevalence of asthma has been lacking. A survey was conducted among 3416 people aged 12 years or older to address this data gap. A questionnaire was used to collect participants' socio-demographics, respiratory symptoms, medical history, and known asthma risk factors.

Participants who reported either a wheeze (difficult, noisy breathing) in the past 12 months, a doctor's diagnosis of asthma, or current use of asthma medications were classified as having asthma. Any one of these three criteria was sufficient for a participant to be recorded as having asthma by the survey organisers.

Of all 323 participants recorded as having asthma, 318 reported wheeze in the past 12 months, 58 had a doctor's diagnosis of asthma, and 25 currently used asthma medications. 270 participants had only one of the three criteria, 28 patients had only two criteria, and 25 participants had all three.

Data from: Kirenga, B. (2019), Prevalence and factors associated with asthma among adolescents and adults in Uganda: A general population-based survey. *BMC Public Health* 19(1).

(i) Calculate the proportion of participants who either reported wheeze in the past 12 months or currently used asthma medications, that had been given a diagnosis of asthma by a doctor before the study.

(ii) Describe how you could construct a confidence interval for the proportion of Ugandan people aged 12 years or older meeting any of the three criteria for asthma.

Discuss any reservations or considerations you have about using this method.

QUESTION FOUR

(a) For patients in the United Kingdom who are hospitalised with influenza, asthma is one of the most common pre-existing medical conditions. Data was collected from patients admitted to 75 hospitals in 31 United Kingdom cities or towns with a confirmed influenza infection. Some of the differences between the patients are listed in Table 3.

Table 3: Treatments and clinical outcomes for asthmatics and non-asthmatics hospitalised with influenza infection

	Asthmatics	**Non-asthmatics**
Total patients	385	1135
Pre-admission treatments:		
Antibiotics	78	202
Antivirals	44	128
Inhaled corticosteroids	203	51
Clinical outcomes:		
Pneumonia	66	188
Severe outcomes (e.g. admission to intensive care)	43	225

Data from: Myles, P. et al (2013). Differences between asthmatics and non-asthmatics hospitalised with influenza A infection. *European Respiratory Journal*, 41: 824-831

(i) Compare the rates of both 'Pneumonia' and 'Severe outcomes (e.g. admission to intensive care)' for asthmatics and non-asthmatics.

(ii) Based on the data in Table 3, describe which pre-admission treatment might best explain the observed differences in rates of severe outcomes for the two groups.

(iii) 19% of all patients in the study had short hospital stays (less than two days duration), of which 71 individuals were asthmatics.

Compare the proportions of short hospital stays for asthmatics compared to non-asthmatics.

Question Four continues on the following page.

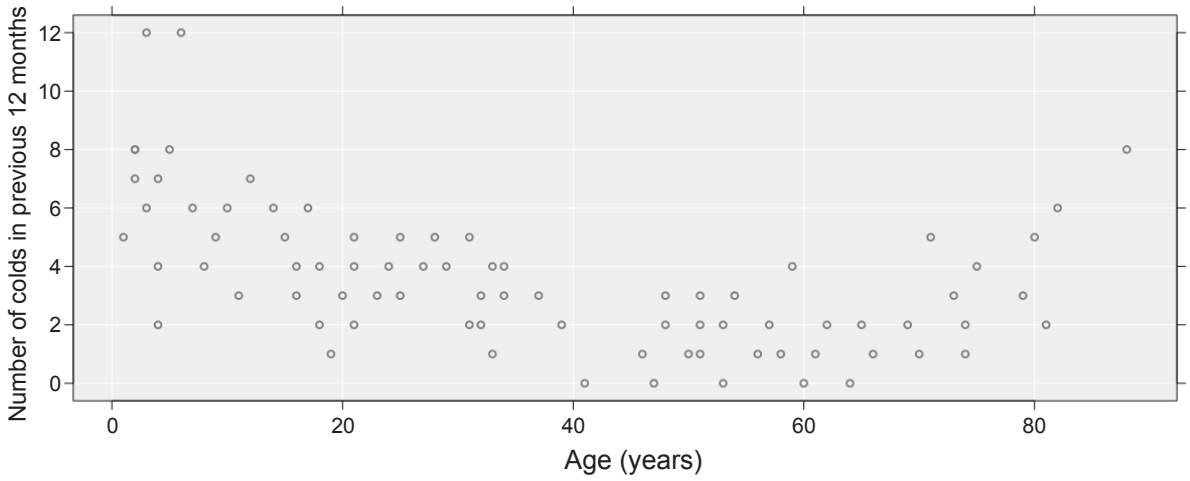
(iv) For the 385 asthmatic patients in this study, the probability that two randomly chosen, consecutive patients are children is 0.0356.

Use this information to determine how many children were in this study.

(b) The New Zealand Ministry of Health claims that as people age, they tend to get fewer colds due to a build up of immunity to some cold viruses. To test this theory, researchers took a random sample of 80 patients from four GP practices in Auckland. These patients were asked to recall the number of colds they had experienced in the previous 12 months. When a patient was under the age of 14, their caregiver was asked to recall the number of colds the patient had experienced in the previous 12 months.

Figure 8 shows a scatterplot displaying each person's age in years plotted against the number of colds each person experienced in the previous 12 months

Figure 8: Number of colds in previous 12 months versus age in years



Identify key features of the data shown in Figure 8, and use these to discuss the relationship between age in years and the number of colds experienced in the previous 12 months.

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