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TOP SCHOLAR



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.

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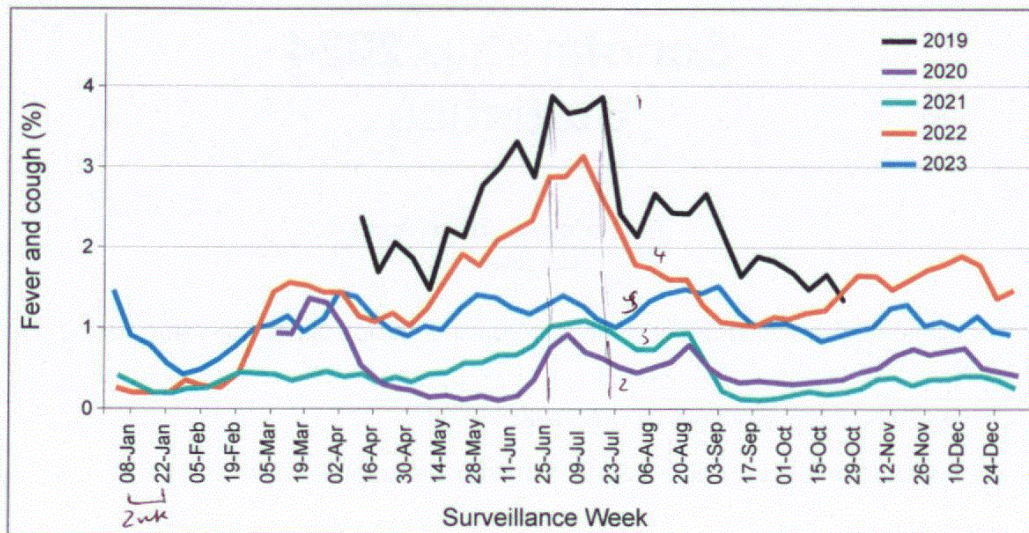
QUESTION ONE

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.

The % of fever and cough symptoms was highest in 2019, overall, although there appears to be missing data (half a year). This dramatically decreases in 2020 to some of the lowest percentages (0.1%) in May and lowest for the peak flu season of Jun and Jul over all the years (1.1%). From 2020, subsequent years start to return to the pattern observed in 2019, with lower % during summer peaking at 1.1% of participants during June/July.

months and peaking in winter, although they stay below 2019. Interestingly, 2022 had higher recorded scores than 2023 for most of the year, breaking the previous trend of a steady increase seen ~~from 2020 to 2021~~ ^{from 2020 to 2021}, however 2023 returns to a very steady report (around 1x) for much of the year.

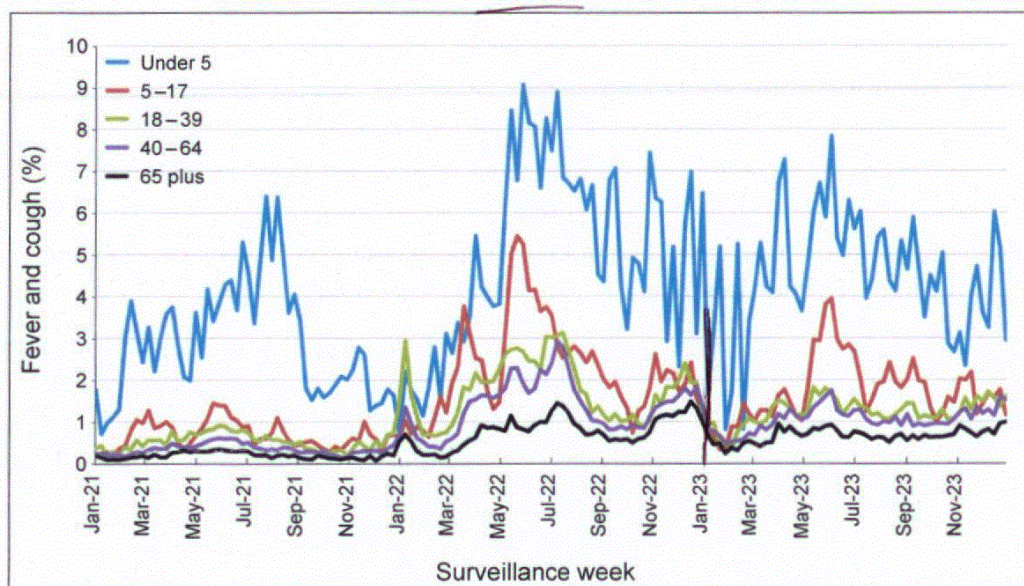
- (ii) Discuss THREE possible limitations of the study design used by FluTracking, including the impact of the design on any conclusions that could be made.

The surveillance/study relies on 'community spirit', self-reporting from participants. This could lead to biased results due to inaccuracies from diagnoses of participants, or underrepresentation due to the Hawthorne effect - participants know they are being observed so they downplay or exaggerate symptoms, based on what is favourable. It is hard to determine parameters for each of the symptoms - they can be vague, when self-reporting. Some symptoms may be due to stress or anxiety due to current events (shortness of breath, headache, etc.). Fevers and sore throats are not defined clearly (eg. $T > 38^{\circ}\text{C}$ or soreness on a scale).

Participants may also have underlying health conditions that impact their symptom frequency and/or susceptibility to disease/flu. (eg. Asthma patients may cough more, and also more likely to get the flu). This could lead to overestimation of the proportion of people with the symptoms over the years.

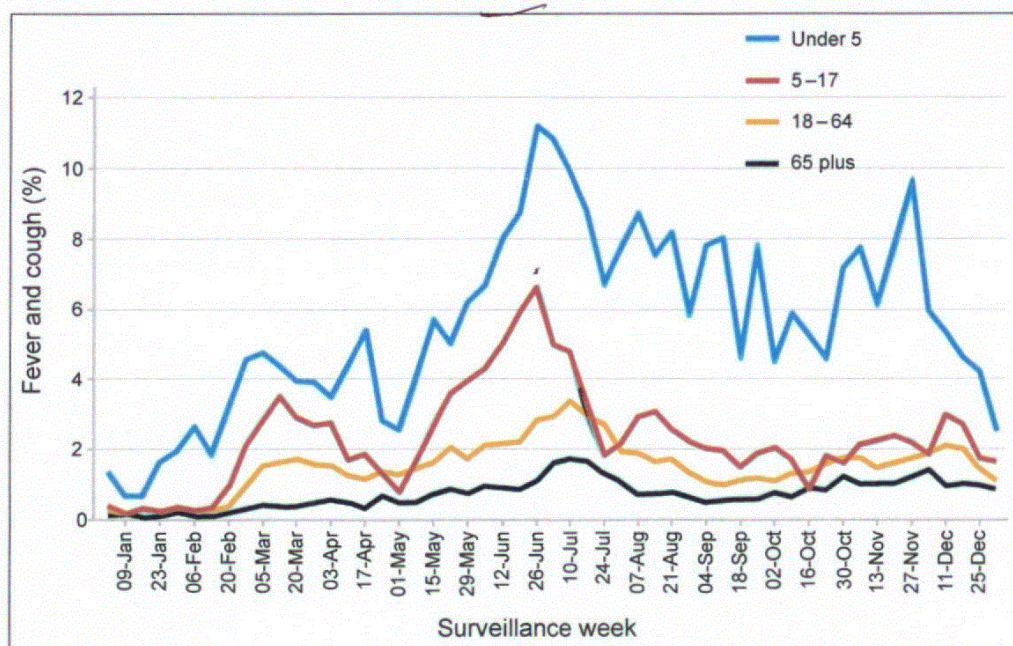
- (b) FluTracking releases weekly reports for both Australia (Figure 2) and New Zealand (Figure 3). These reports include a breakdown of symptoms by age group.

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.

As NZ data only shows 2023 results, ~~these will be for~~ ^{the Australia} comparisons should be the 2023 results, unless we are assuming the pattern is unchanged/very similar in previous years (2021, 2022) which from Australia and ~~the~~ fig 1 is not true.

In both Australia and NZ, the under 5 age group has the highest incidence of fever and cough symptoms by a large margin. This is followed by 5-17, and the others, decreasing as age groups increase (in age).

Under 5s reach a peak of 11% incidence in June in NZ, while they reach only 8% in Australia.

Similarly, 8-17s reach a peak of ~6.5% in NZ at this same time/week while Australia only reached 4%. This may suggest NZ has higher incidence of symptoms for all age groups, comparing again the 18-64 and 65 plus in both countries.

NZ has only 4 groups, 18-64 all in one group while Australia has 18-39 and 40-64.

From fig 2, we see that 18-39 generally report a slightly higher incidence of symptoms than 40-64.

This could be true for NZ also, meaning the younger end of that group (18-64) could be shifting the results higher slightly, overrepresented in that group.

Both countries show similar seasonal effects, with a peak in June (winter) when flu is high, however while Australia has peaks in summer to December (21, 23) NZ

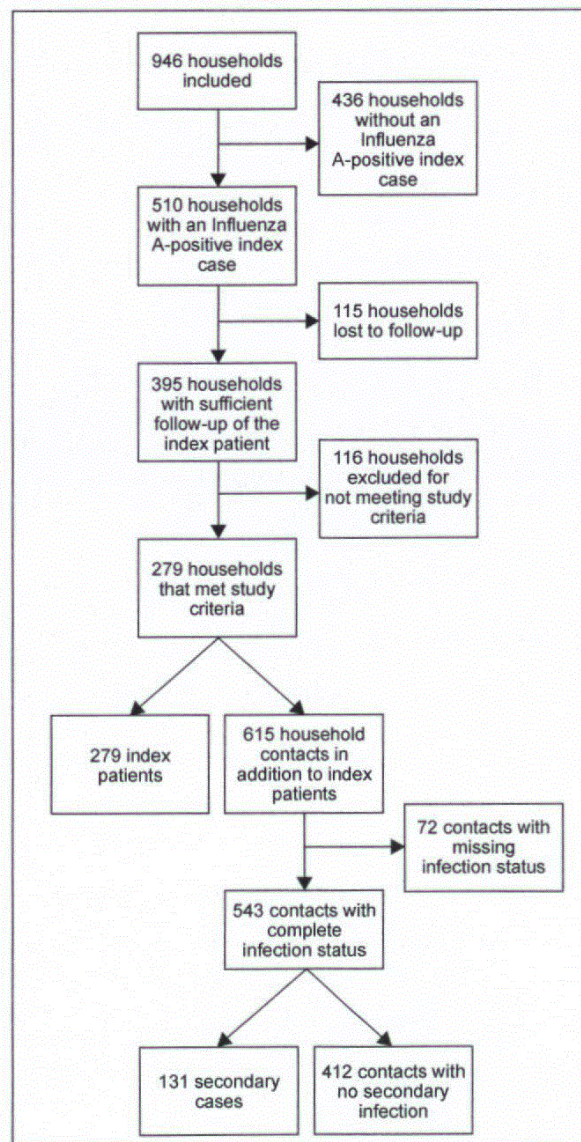
has an earlier one in November. Could be due to seasons changing at different times, or ^(pre) school terms causing a large peak for younger children.

- (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 Practitioner*, 54(506):684-89

7
assume index is adult?

index + households

- (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.

$\bar{x}$ 133?

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

$$\sim n(\text{children}) = 198.09 \text{ in households}$$

72 infection missing
543

$$n(\text{patients}) = 279 + 615 = 894 - \frac{198}{894}$$

$$\hat{p}(\text{children}) = \frac{198}{894} = 0.2215 \text{ of all patients}$$

$\frac{543}{615}$ infection status complete, 131/543 secondary infection

$$0.2215 \times 131 = 29.0165 \Rightarrow 29 \text{ children Secondary cases}$$

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

~~As~~ As the mean number per household was given, this may be affected by outliers - households with many children under 15. Using this 0.71 value to calculate number of children total should be accurate, however as we don't know which household the 615 patients are from, when the 72 contacts are missing, this may have removed children or adults disproportionately from the sample. Therefore the proportion of children in all patients may no longer be accurate/representative, when the 543 are left. Using this to calculate the number of children recorded as a secondary case may also ~~not~~ be inaccurate - children could be more or less susceptible to influenza, so could be underrepresented in this proportion when calculating using the 131 secondary cases.

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

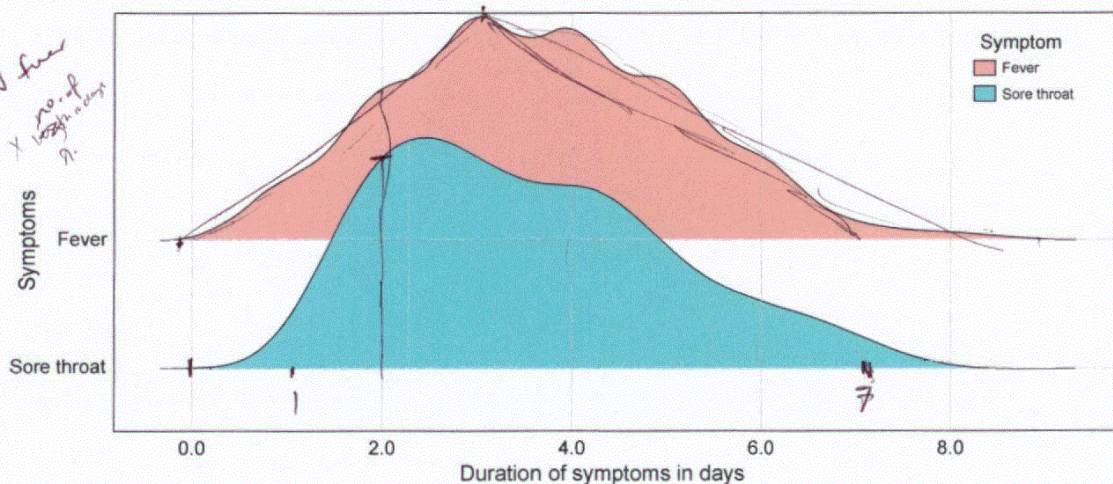
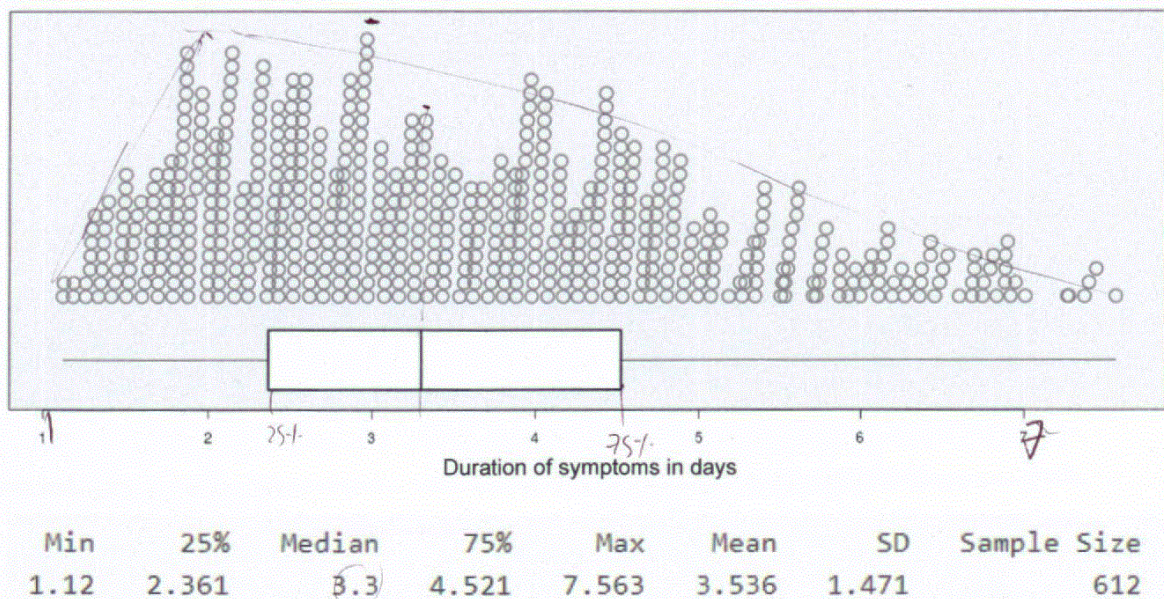


Figure 6 shows the sore throat symptoms, in days, reported by study participants.

Figure 6: Sore throat symptoms in days



- (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.

Could use triangular model with $a=0$, $b=7$, $c=3$, this doesn't take into account the multiple 'peak' or bumpy curves in the density distribution of fever symptoms; may cause underestimation in the upper 50% of data.

Assumes median = mode (mean), however data appears slightly right skewed with a higher density just on the right of the mode which means more than 50% may be above the mode.

Cuts off at 7 days, however it appears there may be an instance of 8 days on figure 5.

$\mu = 4.5 = \frac{4}{3}$ but doesn't look like bell.
 $N(4, \frac{4}{3})$?

- (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.

$$\text{height} = \frac{2}{7-1} = \frac{2}{6} = \frac{1}{3}$$

Triangular distribution assumes median = mode.

The parameter given is $c=2$, although Fig 6 gives median as 3.3, and the mode appears to be at ≈ 3 , although this could be random sampling error.

Using the model, 25% of data $P=0.25$ between $a=1$ and $x = \frac{2(x-1)}{(7-1)(2-1)} = 0.25 \Rightarrow \frac{2(x-1)}{6} = 0.25 \Rightarrow 2(x-1) = 1.5 \Rightarrow (x-1) = 0.75 \Rightarrow x = 1.75$. Compared to Fig 6, says 25% is at 2.36. 75% of data $P=0.75$, using model $x = 4.25$

While Fig 6 says 4.5. The model predicts height of Δ model cannot go above maximum (b) of 7, however Fig 6 shows 7.56%. Still possible to be appropriate but parameters may need adjusting.

- (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. p/year

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.

$$\begin{array}{l|l}
 p_0(5.6) & p_0(4.4) \\
 p(X > 10) = 1 - p(X \leq 10) & p(X > 5) = 1 - p(X \leq 5) \\
 = 1 - 0.9717... & = 1 - 0.7199 \\
 = 0.0282 & = 0.2801 \\
 \hline
 \frac{0.2801}{0.0282} = 9.9 &
 \end{array}$$

$\therefore$ employees were nearly 10x as likely to exceed in 2012 than in 2022

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

~~Poisson~~ Poisson requires events to be independent and random. This may not be true for this data/context as people may develop sicknesses that require multiple days off in a row, ~~Those prone to~~ Those prone to sickness may also ~~not~~ contract recurring illness due to a previous infection/overexposed immunity, which could cause higher occurrences. Poisson models assume probability of event occurring (sick day) is proportional to the amount of time, which is true for this scenario as it is about annual leave, over a whole year - although certain months may have higher numbers of sick days taken.

- (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	2104
December 2023	519	275	794

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.

Margin of error July : rule of thumb: $MOE = \frac{1}{\sqrt{2104}}$ (as $p \approx 0.6815$, $0.3 < p < 0.7$)
 " " " December : $MOE = \frac{1}{\sqrt{794}}$ ($p = 0.6536$, $0.3 < p < 0.7$)

as comparing different independent surveys:

$$ci: (P_{July} - P_{Dec}) \pm 1.5 \times \frac{MOE_J + MOE_D}{2}$$

$$= \left(\frac{1434}{2104} - \frac{519}{794} \right) \pm 1.5 \times \frac{\frac{1}{\sqrt{2104}} + \frac{1}{\sqrt{794}}}{2}$$

$$= (0.6816 - 0.6537) \pm 1.5 \times 0.0286$$

$$= 0.0279 \pm 0.042967$$

$$= [-0.0151, 0.0709]$$

The confidence interval shows that the proportion of NZ taking time off due to ILI in July is between -0.0151 more than those in December to 0.0709 more than those in December. Meaning they are 0.0151 less likely to take off in July to 0.0709 more in July compared to December. This confidence interval contains 0 so there is insufficient evidence to support the claim that they are more likely to take time off (at 95% significance level)

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

Asthma affects more than 500 000 Kiwis, but a ground-breaking New Zealand-led study could be about to change the way patients with the respiratory illness are treated.

Currently, most adults with mild asthma are given two different inhaler medications: a preventer and a reliever. The preventer is an inhaled corticosteroid which is taken twice a day. The reliever is an inhaled bronchodilator which is taken whenever needed to relieve asthma symptoms, such as wheezing.

More than 670 people from New Zealand, the United Kingdom, Italy, and Australia with mild asthma took part in the study's trial – 82 per cent were from New Zealand. Participants had been taking only the reliever medication before they started the study. They were randomly allocated into three groups; one third used a reliever inhaler for 12 months whenever they had symptoms. Another third used both a preventer inhaler twice daily and a separate reliever inhaler whenever they had symptoms. The final group used a single combined preventer-reliever inhaler whenever they had symptoms.

The study showed that the risk of an asthma attack was reduced for those who used the single combined preventer-reliever inhaler. The study's results showed the combined preventer-reliever group's risk of an asthma attack was reduced by 60% compared to those who used a reliever alone. The single combined approach was also shown to have a 56% reduction compared to those who used both medications separately.

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.

The ^(study) test was experimental, with experimental units being each person participating in the study. The independent/experimental variable was the medication ^(type) / inhaler with 3 levels: one group being reliever only, one preventative / reliever separately, one with preventer-reliever combined. The response variable was the risk of asthma attacks, or the reduction in risk from reliever only to the other medications. Probably measured in number of attacks over the ~~the~~ course of the study.

Participants were randomly allocated to ~~the~~ the 3 groups, controlling for variability between participants, ensuring independence so that the results could be attributed to the type of medication alone. Groups were independent.

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

Random allocation reduces effects of any confounding variables that may affect results - Choice between groups may lead to inadvertent correlations arising between the people in the group and the group condition. (eg. those who have frequent attacks may prefer/respond better to preventer-reliever or similar correlations).

Also, it ensures there is enough data for all groups, if $\frac{1}{3}$ was in each, then there wouldn't be skewed results/non-representative from uneven sample sizes.

- (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.

As asthma symptoms are physical and generally unable to be influenced by the afflicted person, it is less likely that the placebo effect could occur and affect the trial. Researchers may have felt it was unnecessary to blind the study.

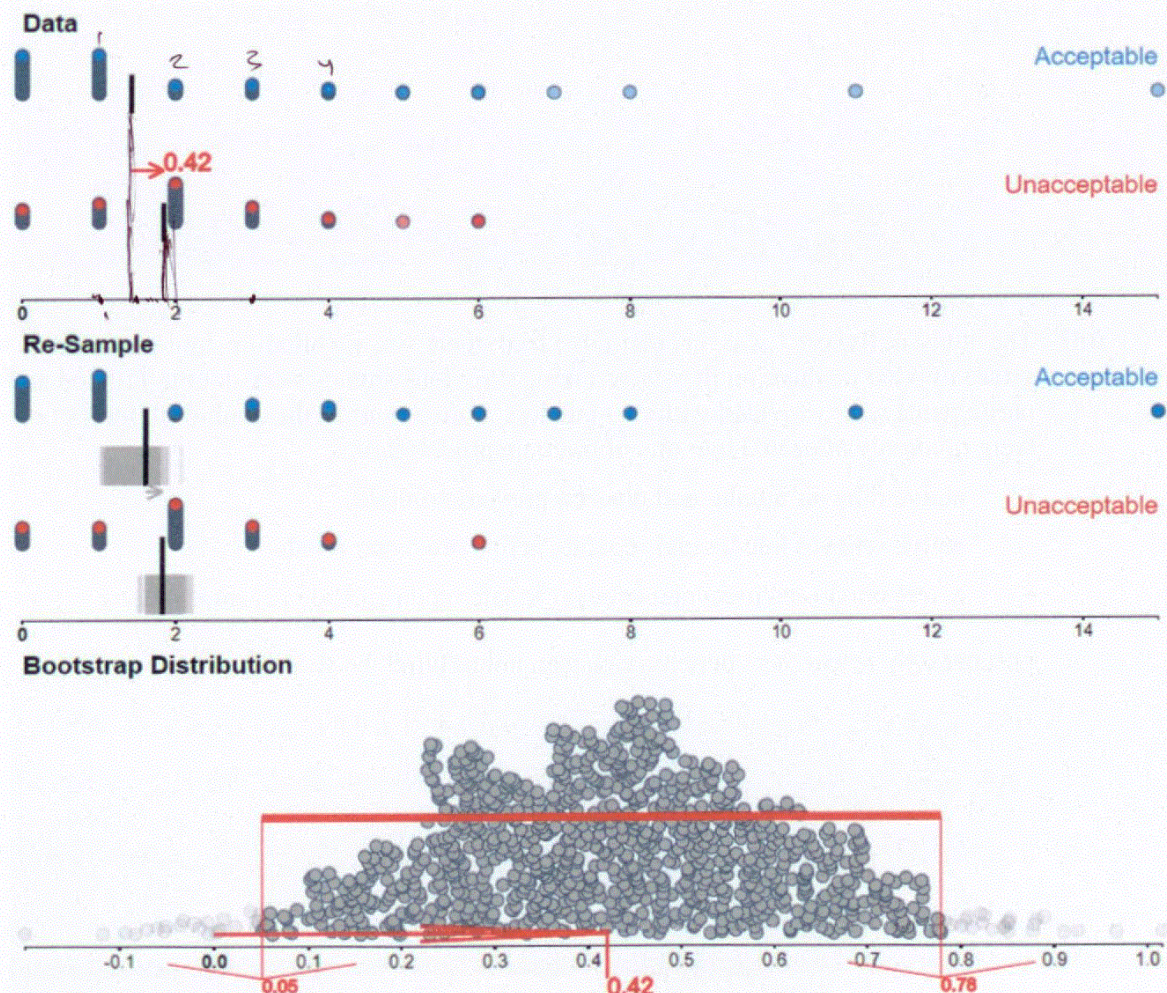
Researchers may have also wanted participants to know what they were taking, as in real life they would, and any positive effects due to a placebo is still beneficial to the patient. Again, it is unlikely that placebo would have large effects on asthma attack risk.

- (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.

From fig 7, the data shows there is a difference between mean number of asthma-related healthcare visits ~~in~~ in households that met Healthy Homes insulation standards (acceptable) and ~~not~~ didn't (unacceptable). The mean number of healthcare visits from unacceptable households was 0.42 higher than the mean in acceptable households in this sample (Around 1.8 compared to 1.4). The bootstrap distribution shows that the mean number of visits in unacceptable households is 95% likely to fall between 0.05 and 0.78 higher than the visits in ~~the~~ acceptable households. As this confidence interval is all above 0 (positive), ~~there~~ there is evidence to suggest ^(no. of healthcare) ~~household~~ visits for asthma ^(in unacceptable households) are higher (average 0.42) than ~~those~~ the number of visits in acceptable households.

Reservations about extending findings from results:

- although ~~the~~ the bootstrap confidence interval suggests there are more asthma related visits in unacceptable insulation, the average/mean difference was 0.42, which is less than 1 extra visit per year.
- the confidence interval ranged between 0.05 and 0.78, although above 0, is still below 1.
- although healthcare visits may be more frequent in unacceptably insulated households, it is difficult to conclude that the insulation caused the higher number of asthma-related concerns, and ~~it is~~ uncertain whether ^(poor) insulation causes asthma concerns (cannot make a causal claim).
- it could be a confounding variable, as for example those with asthma (already taking medication) may be less secure financially and therefore rent lower priced homes that are worse quality (not up to standard)
- These properties in sample were from Otago, Canterbury, West Coast, hard to extend to whole of NZ or even all of south island.

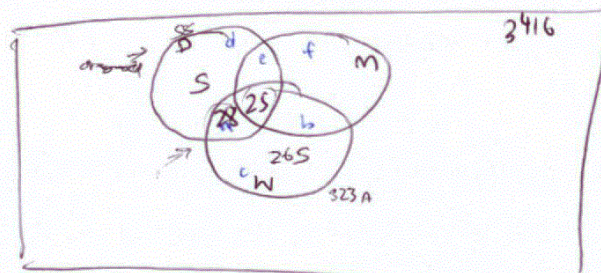
- (c) In Uganda, large-scale population data on the prevalence of asthma has been lacking. A survey was conducted among 3416 people aged 12 years or older to address this data gap. A questionnaire was used to collect participants' socio-demographics, respiratory symptoms, medical history, and known asthma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



$$\begin{aligned}
 W &= 25 + a + b + c \\
 318 &= a + b + c = 25 + 293 \\
 d + e + a &= 33 \\
 e + f + b &= 0 \\
 e + f + b + a &= 28 \\
 a &= 28 \\
 d &=
 \end{aligned}$$

$$P(W) = \frac{318}{3416} = 0.09309$$

$$P(D) = \frac{58}{3416} = 0.01698$$

$$P(W) = \frac{318}{3416} = 0.09309$$

$$P(W) = \frac{318}{3416} = 0.09309$$

$$P(D|W) = \frac{25}{318} = \frac{1}{12.72}$$

$$\approx 0.0786$$

	Wheeze	Doctor	M	Total
Asthma	318			323
No				3093
Total				3416

- (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.

Any of 3 criteria would be recorded as having asthma in this test, so $323/3416 = 0.09456$

Taking $p = 0.09456$, applying it to whole of Uganda, you would have to calculate a margin of error due to the survey being a sample. As the probability is low, the rule of thumb for MoE would not apply, so $\text{moe} = z \times \sqrt{\frac{p(1-p)}{n}}$, at a 95% significance level it would be $1.96 \times \sqrt{\frac{0.09456 \times 0.9054}{3416}} = 9.81 \times 10^{-3}$.

As it was a large sample, and small probability, the MoE is small. Add this to the proportion to gather a confidence interval for proportion of all Ugandan people 12 or older meeting asthma criteria.

Reservations: sample may not be representative of the whole Ugandan population, so the proportion may not be accurate to begin with. Those who are likely to have asthma may not have been able to participate in the survey so the proportion may be inaccurate.

Considerations: proportion is very small, cannot use rule of thumb if calculating MoE.

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.

$$P(\text{Pneumonia} | \text{Asthmatic}) = \frac{66}{385} = \frac{6}{35} = 0.1714$$

$$P(\text{Severe} | \text{Asthmatic}) = \frac{43}{385} = 0.1117$$

$$P(\text{Pneumonia} | \text{non A}) = \frac{188}{1135} = 0.1656$$

$$P(\text{Severe} | \text{non A}) = \frac{225}{1135} = 0.1982$$

$$\text{relative risk pneumonia} = \frac{0.1714}{0.1656} = 1.035$$

$$\text{r " " severe} = \frac{0.1982}{0.1117} = 1.774$$

asthmatics are 1.035 times ^{as} likely to ~~contract~~ pneumonia after admission for influenza ^{as} non asthmatics. ~~however~~

However, non-asthmatics are ~~the~~ 1.774 times as likely to be admitted into intensive care as asthmatics.

Pneumonia: asthmatics are likely
to intensive care: 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.

Treatment	Antibiotics : asthmatics	$78/385 = 0.2026$	} 1.138x
	non	$202/1135 = 0.1780$	
	Antivirals : asthmatics	$44/385 = 0.1143$	} 1.013x
	non	$128/1135 = 0.1128$	
	Corticosteroids : asthmatics	$203/385 = 0.5273$	} 11x
	non	$31/1135 = 0.0476$	

The observed differences are most likely due to the treatment of inhaled corticosteroids pre-admission, as over half asthmatics were treated with this (52.7%) compared to the lower number of non asthmatics (4.8%).

The other treatments have similar proportions of those taking it between asthmatics and non asthmatics (1x and 1.01x as likely) compared to corticosteroids, which a much greater proportion of asthmatics had, (11x as likely), so it could be this causing the lower rate of severe outcomes in asthmatics.

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

<2

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

19% of total patients = 288.8 patients (289)

$71/288.8 = 0.2458$ (25% of short stays)

$217.8/288.8 = 0.7542$ (75% of short stays non asthmatic)

around 25% (1/4) of short stays were asthmatics, meaning around 75% were non-asthmatics.

Non-Asthmatics are 3 times as likely as asthmatics to have short stays, meaning asthmatics are more likely to have longer stays in hospital (also 3x).

Non asthmatics have shorter stays in hospital

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.

replacement?

Use this information to determine how many children were in this study. to total? or asthmatic non/asthmatic

$$\frac{n}{385} \times \frac{(n-1)}{384} = 0.0356$$

$$\frac{n(n-1)}{147840} = 0.0356 \quad - \frac{b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$n(n-1) = 5263.104$$

$$n^2 - n = 5263.104$$

$$n^2 - n - 5263.104 = 0$$

$$n = \frac{1 \pm \sqrt{1 - 4 \times (-5263.104)}}{2}$$

$$= 73.04, -72.04$$

n cannot be negative, discard

~ so 73 asthmatic children in study?

whole study: assume same proportion? however asthma may be more common in children

$$\frac{73}{385} \approx 0.1896$$

$$0.1896 \times 1135 = 215.2$$

so 215 in non-asthmatic

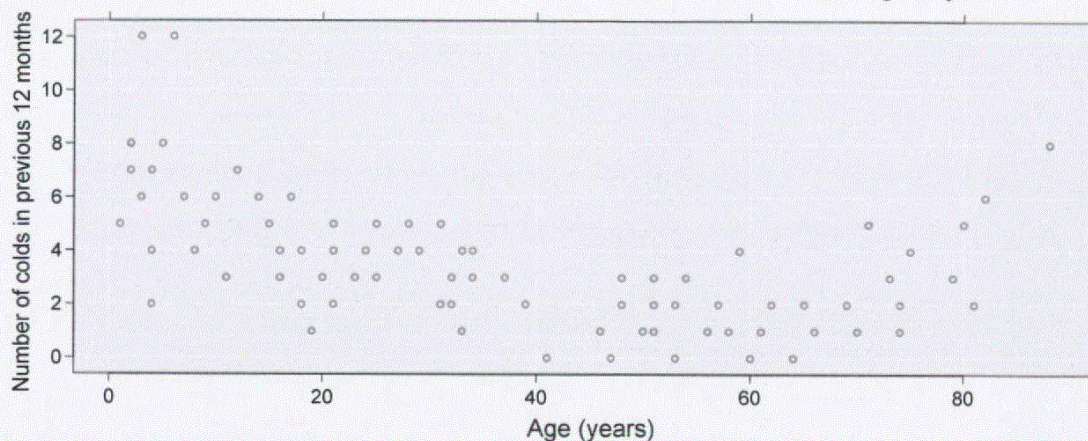
$$\frac{73}{385} \times \frac{72}{384} = 0.0356$$

[Signature]

- (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.

There appears to be a non-linear relationship between age in years and number of colds experienced - almost parabolic in shape is the best fit, so a quadratic model may be best suited. There is even scatter throughout of using a quadratic model, however is more spread near the lower years of age. This could be due to children being susceptible to many viruses and also experiencing a wide range of new foreign objects. There is a decreasing trend up to around 60 years of age, where the number of colds decreases as the age increases, which supports the claim. However, as the age increases past 60 and toward 80, there is a positive relationship between number of colds and age, suggesting that as people age here, immunity decreases again (more colds).

Extra space if required.

Write the question number(s) if applicable.

QUESTION
NUMBER

1b) 'Trough' or low points occur in January in both countries - holiday/Summer causes low reporting?

1ai) Factors such as Covid and subsequent lockdowns likely caused sudden decrease in 2020, when people were less interacted with each other and also more careful. Or, scared to report it (Hawthorne). Always peaks in winter (Jun-Jul) and during March (sudden cooling of weather into Autumn perhaps)