have been able to sustain bigger populations.

Nakatsuka *et al*. also report that modern Native American Chumash people are direct descendants of individuals who inhabited the northern Californian Channel Islands and the Santa Barbara coast around 7,400 years ago. In many regions of America, genomic analyses suggest that present-day Native American individuals tend to be direct descendants of individuals who inhabited the same regions in the past[5]. Interestingly, this trend seems to contrast with patterns seen in Europe, where individuals living in a particular area tend not to be direct descendants of those who lived there thousands of years ago[6].

There is evidence to suggest that ancient individuals in South America and Polynesia made contact with each other before the arrival of European colonizers[7]. A similar contact might have been established between Polynesians and Native Americans of North America, given that a type of canoe used by people in ancient California is thought to reflect the influence of Polynesian cultures[8]. However, Nakatsuka and colleagues found no genetic evidence for contact between individuals of Polynesia and North America. This finding challenges theories of possible Polynesian genetic and cultural influence before colonization in North America.

Analysis of ancient DNA has allowed scientists to study migrations that took place across the Americas[9,10]. However, a complete story describing the movement of people and cultures across every region of North, South and Central America requires studies that incorporate large numbers of samples from across space and time, and that use both present and ancient DNA. This gap has started to be filled by thorough sampling of genomic data from present-day individuals across Mexico[11]. Similar efforts in other countries across the Americas will hopefully take place in the future.

By taking samples of DNA from different regions of Aridoamerica, from individuals dating to between 7,400 and 200 years before the present, Nakatsuka and colleagues can infer information about past migration events that would be difficult to detect using only present-day DNA. Therefore, it is probable that further ancient DNA studies, incorporating samples from individuals who lived across different times and regions in the Americas, will help to paint a fuller picture of the movement of ancient civilizations here. In Mexico, for example, there is archaeological evidence of people leaving certain areas because of environmental factors, such as droughts[3]. The collaboration between geneticists and archaeologists is essential to understand why large migrations might have taken place.

The study by Nakatsuka *et al*. includes co-authors who belong to Indigenous communities with connections to the ancient individuals whose genetic data were analysed. Such an effort is deserving of recognition. Future ancient DNA studies should similarly strive to avoid 'helicopter science' — in which researchers from privileged settings carry out studies in areas where historically marginalized groups live, without involving local communities or researchers. In the case of ancient DNA research, it would be particularly encouraging to see studies that promote the development of local research facilities and training programmes, and the meaningful involvement of academics and communities who are from the regions from which ancient DNA is sampled[12].

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Health care

Diabetes prevention programme put to the test

Edward W. Gregg & Naomi Holman

Causal evidence shows that referring people who are at risk of developing diabetes to a nationwide lifestyle-change programme can result in health improvements — but only if programme participation can be sustained. **See p.138**

For the past seven years, England has taken one of the world's boldest approaches to the prevention of type 2 diabetes. The National Health Service Diabetes Prevention Programme (NHS DPP) is a community-based, structured lifestyle programme, which offers at least 13 sessions to participants. The programme is designed to help adults at high risk of developing diabetes to improve their diet, increase their physical activity and attain a healthy weight[1]. On page 138, Lemp *et al*.[2] report a multi-faceted analysis that evaluates how impactful this kind of large-scale intervention really is.

Type 2 diabetes is a metabolic disease associated with excess sugar in the blood that can lead to diverse complications, including diseases of the eye, kidneys, feet and cardiovascular system. Although the risk of developing type 2 diabetes varies from person to person, it is heavily influenced by lifestyle factors such as diet and exercise.

Almost three decades of randomized controlled trials (in which study participants are assigned randomly to a treatment or control group) have shown that structured lifestyle interventions (Fig. 1) can reduce the risk of diabetes by up to 58% (refs 3,4). Such interventions have also been shown to improve cardiorespiratory fitness and physical function, and decrease the likelihood of participants developing diabetes complications such as chronic kidney disease or symptoms of depression[5].

However, many specialists have questioned whether scaling up targeted lifestyle-change programmes will be effective in tackling the type 2 diabetes epidemic. Cultural and community factors play a big part — these range from the foods that people prefer and have access to, to the methods of transport available and the leisure activities that people engage in[6]. Doubts stem from the logistics and cost of such programmes, and their diluted effectiveness when they are implemented in the real world[5]. Indeed, small 'translational' trials have shown that adapting these interventions to community settings does promote behaviour change and weight loss, but less effectively than the most intensive trials carried out in research settings[5–7].

Only a few countries and large health systems have tried to make preventative measures available to the whole population of at-risk

individuals through policies, community structures and financing. These measures have rarely been applied in low- or middle-income countries, where the major future burden of type 2 diabetes lies[1,8,9]. Crucially, studying the effectiveness of these approaches at a large scale is challenging because of the lack of randomization (the random assignment of participants to treatment and control groups) and the inherent biases affecting who participates in such programmes.

Lemp and co-workers address some of these challenges by measuring the effectiveness of the NHS DPP using a suite of rigorous 'quasi-experimental' analyses. Such methods can be applied when participants in a study belong to pre-assigned, non-randomized groups — in this case, individuals who were or were not eligible to take part in the programme, according to their blood sugar levels.

The authors found that referral to the NHS DPP is associated with only a modest reduction in glycated haemoglobin (HbA1c), a measure of blood sugar levels, which is a key biomarker used to diagnose and assess the progression of diabetes. However, Lemp *et al.* estimate that active participation in the programme is associated with a degree of improvement of HbA1c levels that should substantially slow an individual's progression to diabetes and cardiovascular disease.

There was a statistically significant but clinically negligible reduction in HbA1c among all the people who were eligible for the programme. In the 17% of eligible people who ended up being referred, the reduction was much greater (but still modest — about one-third of the effect observed in intensive randomized controlled trials that found the most convincing effects on reducing diabetes incidence[3,10]). However, when accounting for only the 28% of people who were referred and actually attended the programme, the reduction in Hb1Ac became substantial and on par with that seen in trials.

This cascade of lowered risk — which was greatest in those who actively participated in the programme — reflects the crux of the challenge for individual-level prevention approaches. The success of these strategies depends heavily on strong engagement and adherence to the programme, and perhaps the identification of people who will respond well to lifestyle intervention in the first place. It is also a reminder that approaches targeted to the individual cannot go it alone: a combination of individual- and population-based approaches that address a wide variety of risk factors are needed to change the course of the type 2 diabetes epidemic.

Lemp and colleagues' primary analysis used an approach called a regression discontinuity design — they compared changes in HbA1c, weight, blood pressure and other measurements relating to diabetes complications between people who were referred to the NHS DPP and people whose HbA1c levels were just below the threshold for programme eligibility. This approach works well when an arbitrary threshold determines who receives an intervention and no other substantial differences in health status or access to health care exist between the groups[11]. Further confidence in the authors' results comes from their use of other analyses that compared between intervention and control groups matched for health characteristics (such as age and health status) and between different cohorts of participants. The authors' analyses also showed that the referral threshold was not associated with

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Figure 1 | A group counselling session as part of a community-based diabetes prevention programme. Lemp *et al.*[2] find that such lifestyle-intervention strategies are effective in reducing an individual's risk of diabetes, as long as the programme is adhered to.

From the archive

Scientific investigation of inexplicable events, and a biological solution for preventing flood damage.

50 years ago

Britain has recently been experiencing the strange happenings that seem to accompany Mr Uri Geller wherever he takes his one-man show. Knives and forks have been bent, broken watches restarted and feats of apparent telepathy performed. No generally accepted explanation is yet forthcoming ... [H]e claims to be doing these strange things not as an illusionist using sleight of hand or deceptive material but as someone invested with a previously unappreciated power ... [I]t is to be hoped that the proposal by the *New Scientist* that he submit to examination by its panel will be taken up, even though he has already been examined extensively by a team at Stanford Research Institute.

From *Nature* 7 December 1973

150 years ago

Prof. N. L. Shaler, Geologist of the State of Kentucky, in a recent letter to the *Frankfort Yeoman*, makes a rather novel suggestion for improving the navigation of the Ohio River, and at the same time preventing the enormous destruction of property which its floods now occasion at intervals ... In what has hitherto proved a vain endeavour ... a large amount of money has been already spent ... for wing-dams and other structures to concentrate the flow during the season of slack water; and schemes have been considered ... that involved the expenditure of from ten to forty million dollars. The waste by floods, of property bordering the river, is estimated by Prof. Shaler at 400,000 dols. per annum.

He thinks that both objects could be accomplished by simply planting willows upon the banks ... [W]herever such a plantation has been effected, the resulting growth not only holds the soil in which it is rooted, but accumulates that which is brought down by the river. When the banks have been sufficiently strengthened and extended by means of such plantations, a deepening of the channel must result, which will improve navigation.

From *Nature* 4 December 1873

receipt of other recommended services (such as cancer screening) and therefore it was not associated with special attention from health services.

However, the study lacked a direct assessment of the extent of programme participation, such as the number of sessions that were attended, which has previously been shown to be the strongest tangible predictor of changes to HbA1c and weight[1]. This reflects the systemic gap in health-system data sets for reporting outcomes related to an individual's behaviour, participation and quality of life. Filling this gap will be key to improving studies of real-world strategies that seek to prevent disease.

The most unsatisfying aspect of the study was the counter-intuitive increase in diabetes diagnoses in people who were referred to the NHS DPP compared with those who were not. The authors attribute this to the difficulty in identifying diabetes diagnoses on the basis of data recorded by health services during routine care. However, because methods of identifying diabetes diagnoses from electronic health records are well-developed[12], other explanations seem more probable – such as higher baseline levels of weight and HbA1c in referred participants that meant progression to diabetes was more likely than in people who weren't referred to the NHS DPP.

Type 2 diabetes stands out among contemporary global health problems for the potential – yet missed opportunities – to reduce its incidence. Cohort studies have identified dozens of modifiable risk factors, ranging from diet and physical activity to sleep and air quality, and environmental toxins[13]. New drugs that treat obesity are also primed to reduce the risk of diabetes[14], and supplementation with vitamin D might even reduce risk of developing the condition in people with prediabetes[15].

Unfortunately, there are few organized efforts to address modifiable risk factors, and there is often a lack of clear policies that can be implemented to reduce diabetes risk. Policy-level approaches have so far focused on taxing unhealthy foods and subsidizing healthy options, communications and marketing that aim to influence behaviour, and education and urban planning to enable physical activity.

When population-wide interventions are implemented, they are difficult to study with conventional experimental approaches because of the practical and ethical challenges associated with randomization. At the same time, there has been a rapid proliferation of large-scale digitized health data and non-health data, including information about geographical location, marketing information and data from social media or wearable devices such as smartwatches. Together these factors are spurring an increase in 'natural' experimental studies of pre-existing groups and a demand for rigorous quasi-experimental designs to measure intervention effectiveness in contexts in which randomization is not feasible[16].

Lemp and colleagues' careful and rigorous methods are a valuable addition to diabetes prevention research. Although this study will not end the debate on how to implement diabetes prevention strategies across whole populations, it provides a precedent for stronger evaluation of the programmes that are already under way, and facilitates evidence-based approaches that cater to different parts of the population.

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Climate change

Emissions scenarios and targets aligned

Chris D. Jones & Alexander J. Askew

A mismatch in how carbon emissions are reported could endanger nations' best efforts to meet targets for curbing climate change. A method for translating between reporting conventions offers a path forward. **See p.102**

To halt anthropogenic climate change, the world must strive for 'net zero' emissions. The goal of net zero sounds simple – if humans stop causing carbon dioxide emissions, the world stops getting hotter. But a subtlety in the way that anthropogenic emissions are defined has increased the risk that this goal might not be met. On page 102, Gidden *et al.*[1] suggest a way of translating between existing definitions to address the issue.

It has been known for some time[2] that there is a mismatch in the ways in which different organizations define carbon emissions. The issue stems from land-use classifications, and how land use changes through activities such as deforestation. The Intergovernmental Panel on Climate Change (IPCC) defines anthropogenic on the basis of actions and processes: which processes are caused by humans, and therefore anthropogenic, and which are natural? For example, the response of forests to a changing climate would be considered natural, whereas cutting down trees would not.

By contrast, the United Nations Framework Convention on Climate Change (UNFCCC) requires that its members provide a national greenhouse-gas inventory (NGHGI) every year, using a definition that is based on geography: is a given carbon sink or source located on 'managed' land (in which case it is classed as anthropogenic) or 'natural' land? Managed land broadly refers to any land that has been subject to human intervention – including, for example, both croplands and conservation areas. If a natural process occurs on managed land, it can therefore be reported differently according to these two definitions, leading to confusion and missed targets (Fig. 1).

To explain how this plays out, it's helpful to understand the origin of the term net zero. Back in 2009, several independent studies[3–8] showed that the expected increase in global temperature this century depends on the total amount of CO_2 emitted. Any climate goal should therefore include a cap on CO_2 emissions, known as a carbon budget. 'Budget' implies that some accounting is required to measure total emissions: collective global actions that generate emissions can be balanced by activities that remove carbon from the atmosphere, resulting